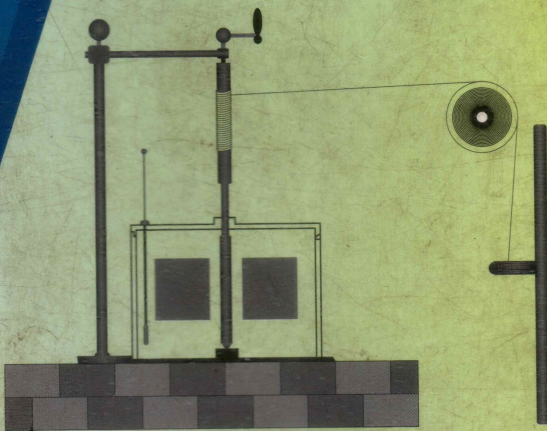


FUNDAMENTALS OF MECHANICAL ENGINEERING

Volume-II



Job Solution
Including BCS
Departmental (ME)
Exam Questions (Eight)
Solution

Fundamentals of Mechanical Engineering

[Volume-II]

Job Solution

Emran Hossain

BSc Engineering (Mechanical),
Rajshahi University of Engineering & Technology.

2021

Fundamentals of Mechanical Engineering

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Dedicated to the memory of my departed sibling

Farjana (Boby)

216-6

1-22-2020

PREFACE TO THE FIRST EDITION

It is really a matter of pleasure to represent the new treatise named “Mechanical Engineering Job Preparation” – a guide to take preparation for all kinds of recruitment examination pertinent to Mechanical Engineering. The story behind this book is to provide a complete idea about the competitive recruitment examination as it is very rare to find out a book that provides proper assistance in this crucial stage.

I wish to express my sincere thanks to all of my friends, seniors and juniors for sending their valuable suggestions and for giving effort behind the publication of this book.

Any errors, omissions and mistakes, for the improvement of this volume brought to my notice, will be thankfully acknowledged and rectified in next edition.

- Emran Hossain

PREFACE TO THIS PRINT

“Fundamentals of Mechanical Engineering Volume II” is basically a Job Solution Manual for BSc Mechanical Engineers. Great news for the job seekers that in this edition we have included eight recent written questions solution of BCS exam. So, hopefully it will be helpful for the BCS written exam preparation as well as for all the exam preparations under BPSC.

Although we have tried to do the entire task carefully, you are requested to take the unavoidable mistakes cordially. All the readers are requested to inform us about the mistakes if found. We will be grateful to you.

Best wishes for all.

- Emran Hossain

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North West Power Generation Company Limited (NWPGL)

Post: Assistant Engineer (Mechanical)

Time 10.00AM to 11.30AM

Date: 04.12.2015

Exam Hall: ECE Building, BUET

Non-Departmental MCQ-60; Departmental MCQ-12; Written-12

Total Marks-40+12+48=100

Non-Departmental:

1. Who was man of the series in the last (2015) Bangladesh vs Zimbabwe ODI series?
a. Tamim Iqbal b. Shakib Al Hasan c. **Mushfiqur Rahim** d. Mostafizur Rahman
2. What is the name of present president of Nepal?
a. **Bidhya Devi Bhandari**
3. What is the length of Padma River?
a. **24000 ft** b.

Notes: Length of Padma River = 120 Km, Length of Padma Bridge = 20180 ft.

4. What is the name of ruling party of Myanmar?
a. USSD b. **NLD** c. NDL
5. What is "Elysee Palace"?
a. **president residence** b. prime minister residence c. king residence
6. The highest average salinity amongst the following seas is reported from
a. **Dead Sea** b. Red Sea c. Black Sea d. Mediterranean Sea
7. The Suez canal connects the
a. Baltic sea and the Caspian sea b. **Mediterranean sea and the Red sea**
c. Red sea and the Caspian sea d. Mediterranean sea and the North sea
8. Supersonic plane fly with the speed
a. less than the speed of sound b. of sound
c. **greater than the speed of sound** d. of light
9. The inert gas which is substituted for nitrogen in the air used by deep sea divers for breathing, is
a. Argon b. Xenon c. **Helium** d. Krypton
10. Siphon will fail to work if
a. the densities of the liquid in the two vessels are equal
b. **the level of the liquid in the two vessels are at the same height**
c. both its limbs are of unequal length
d. the temperature of the liquids in the two vessels is the same
11. Who is the writer of "Ignited Mind"?
a. Arundhati Roy b. **A.P.Z. Abul Kalam**
12. Which of the following statement is false?
a. **boron acts both as metal and non-metal**

[13-15 সংগ্রহ করা সম্ভব হয়নি।]

16. যে জমিতে ফসল ফলে না-

(a) উষর (b) পতিত (c) অনর্বর

17. দাতা এর প্রকৃতি-প্রত্যয় কি?

(a) দা+ ত্চ (b) দা+তা (c) দাত+ আ

18. সনেট কোন ভাষার শব্দ?

(a) আরবি (b) ফারসি (c) ইংরেজি (d) সংস্কৃত

বি. দ্র.: সনেট ইতালীয়ান ভাষা থেকে এসেছে।

19. কোনটি সঠিক?

(a) মুমূর্ষ (b) মুমূর্ষু (c) মুমূর্ষু (d) মুমূর্ষ

20. হরতাল কোন ভাষার শব্দ?

(a) গুজরাটি (b) সংস্কৃত

21. রামছাগল- এখানে রাম কি অর্থে ব্যবহৃত হয়েছে?

(a) উৎকৃষ্ট (b) নিকৃষ্ট

22. কোনটির লিপ্যন্তর হয়?

(a) রাষ্ট্রপতি (b) কবিরাজ (c) সাহেব

23. নৈসর্গিক এর বিপরীত শব্দ কি?

(a) প্রাকৃতিক (b) কৃত্রিম (c) দিবাকালীন (d) রাত্রিকালীন

24. প্রাকৃত অর্থ কি?

(a) স্বাভাবিক (b) যথাযথ (c) ভাষা

25. “সবকটা জানালা খুলে দে না” - এর রচয়িতা কে?

(a) আলতাফ মাহমুদ (b) নজরুল ইসলাম বাবু (c) গাফফার চৌধুরী

26. বৈকুণ্ঠের উইল কার লেখা?

(a) রবীন্দ্রনাথ ঠাকুর (b) ঈশ্বরচন্দ্র বিদ্যাসাগর (c) শরৎচন্দ্র (d) বঙ্কিমচন্দ্র

27. কার কথা বাসি হলেও ফলে?

(a) কাঙালের (b) বড়লোকের (c) গরিবের

31. Which sentence is correct?

a. paper is made from wood b. paper is made of wood c. paper is made at wood d.

32. Choose the correct answer

a. Why have you done this? b. why you have done this?

33. Choose the correct sentence

a. I forbade him to go b. I forbade him from going

c. I forbade him going d. I forbade him not to go

34. Our Head office _____ us for travelling?

a. Pays, b. Gives, c. Remunerates d. both a and c

35. Who is the writer of “Romeo Juliet”?

a. William Shakespeare

36. What is the plural of “Hypothesis”.

a. Hypotheses b. Hypothesies c. Hypothesis

46. If we enter any text in cells of MS Excell then it is by default aligned to

a. left b. right c. middle d. none

47. Which keyboard shortcut command is used for cut option?

a. Ctrl + X

48. Which is the primary memory of a computer?

a. RAM b. cache c. hard disk d. pen drive

49. A person buys something in 2000 taka. He sells some of these things in 25% profit and some in 25% loss. Which statement is true?

- a. he made profit of more than 125 taka b. he made profit of less than 125 taka
c. he is in loss of more than 125 taka d. he is in loss of less than 125 taka

N.B.: Data is insufficient to answer the question.

50. If an equilateral triangle is inscribed in a square of unit side, then the length of the side of triangle is

- a. $\sqrt{6}-\sqrt{2}$ (b) $\sqrt{3}/2$

51. $3a=b$ and $3c=d$ then $bd=?$

- a. $3a+b$ (b) $3ab$

(28-30); (37-45); **(52-60)** [সংগ্রহ করা সম্ভব হয়নি।]

Departmental:

1. A rotometer is used to measure

- (a) Velocity of fluids (b) viscosity of fluids
(c) Density of fluids (d) discharge of fluids.

2. Which statement is correct?

- (a) Bending moment at the top surface of a beam is compressive.
(b) The neutral axis of a transverse section of a beam passes through the center.

3. Which stress is critical for transverse vibration of a shaft?

- (a) Torsional stress (b)

4. For diffuser which one is correct ____.

- (a) Kinetic energy converts into pressure energy**
(b) Pressure energy converts into mechanical energy
(c) Pressure energy converts into kinetic energy

5. Kaplan turbine is used to produce-

- (a) Low head high discharge** (b) Low head low discharge
(c) High head low discharge (d) Low head high discharge

6. For separation which one is the cause?

- (a) Vapor pressure is greater than cylinder pressure**
(b) Vapor pressure is less than cylinder pressure

7. 200g water evaporates in 10min. find the evaporation rate.

- (a) 45.1Kj/min** (b) 10.1 kj/min

8. Specific gravity of oil is 0.8. if the water head is 1m find the corresponding Oil head-

- (a) 0.8 **(b) 1.2** (c) 9.81

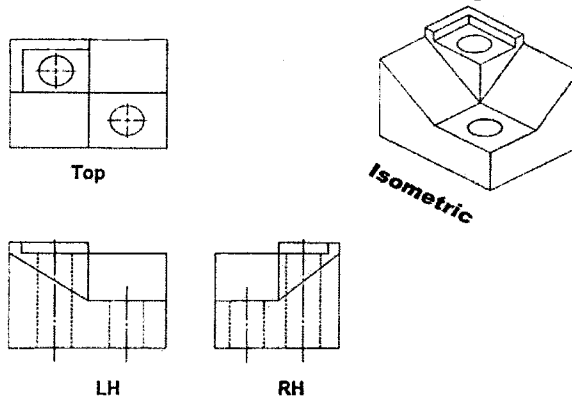
9. The purpose of a surge tank is

- (a) to control the pressure variations due to rapid changes in the pipe line flow
(b) to eliminate water hammer possibilities
(c) to regulate flow of water turbines by providing necessary retarding head of water
(d) all of the above

10. Falling drops of water become spheres due to the property of

- (a) surface tension of water** (b) compressibility of water
(c) capillarity of water (d) viscosity of water

11. Draw TOP view, FRONT view and RHS view of the figure below:



12. What is boiler mountings and accessories? Give two examples each of them.

Answer:

Boiler Mountings: Mountings are required for proper and safe functioning of the boiler, which is generally mounted over the boiler shell.

Examples: Water Level Indicator, Pressure gauge, Safety valves, Steam stop valve, Blow off cock, Fusible plug, Feed Check valve.

Water Level Indicator:

- The water level indicator is needed to ascertain the water level of a boiler.
- Two water level indicators should be fitted for each boiler in such a place that the water level can be constantly seen.

Pressure Gauge:

- A pressure gauge is an instrument by means of which the pressure exerted inside a vessel can be measured.
- There are two types of pressure gauges, one is Bourdon tube pressure gauge and the other is diaphragm type gauge.

Boiler Accessories: Accessories are used for efficient running of the boiler but they are not mounted on the boiler shell. Boiler accessories are-

- Superheater: super heater is a device used for drying wet steam and then increasing temperature of the dry steam without increasing its pressure by utilizing the heat of combustion product.
- Economizer: Economizer is a device used for heating feed water which is supplied to the boiler by utilizing heat in the exhaust flue gases before leaving through the chimney.

13. Calculate the refrigeration tonnage for 3000kg ice from 0°C to 30°C.

Solution:

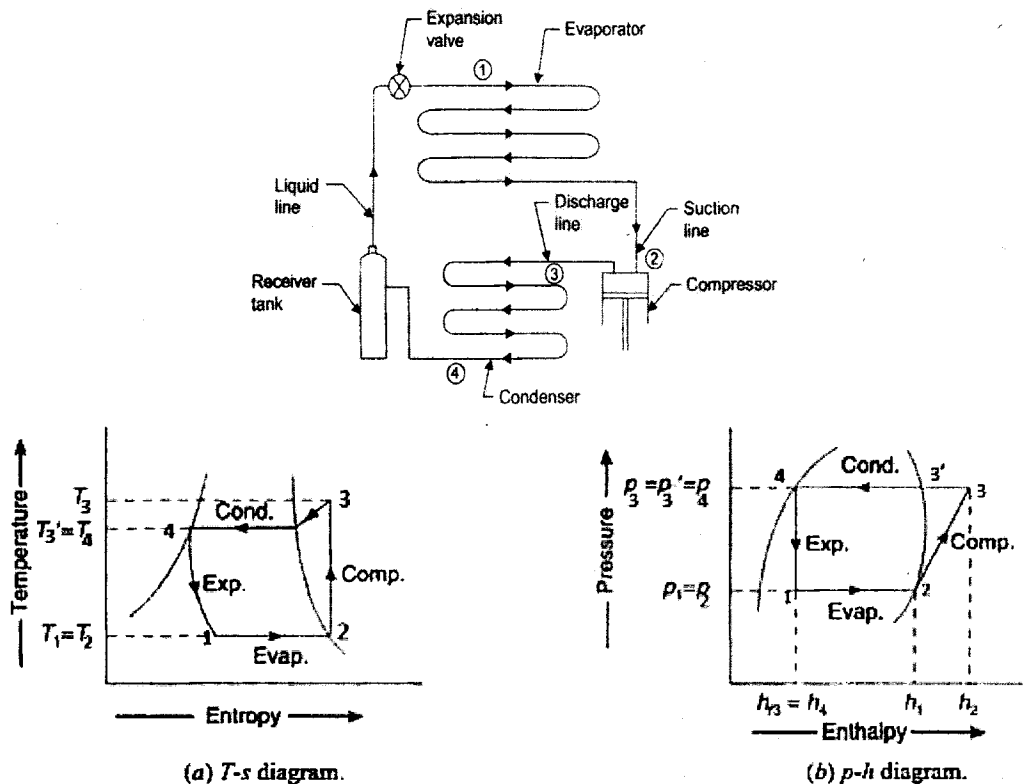
Here, $m = 3000\text{kg}$; $\Delta\theta = (30^\circ - 0^\circ) = 30^\circ\text{C}$

$$\begin{aligned} \text{We get, amount of heat} &= \frac{m l_f}{24 \times 60} + \frac{m s \Delta\theta}{24 \times 60} = \frac{3000 \times 333.5}{24 \times 60} + \frac{3000 \times 4.2 \times 30}{24 \times 60} \\ &= 957.29 \text{Kj/min} = \frac{957.29}{210} \text{ ton} = 4.55 \text{ ton} \end{aligned}$$

\therefore Refrigeration tonnage = 4.55 (Answer)

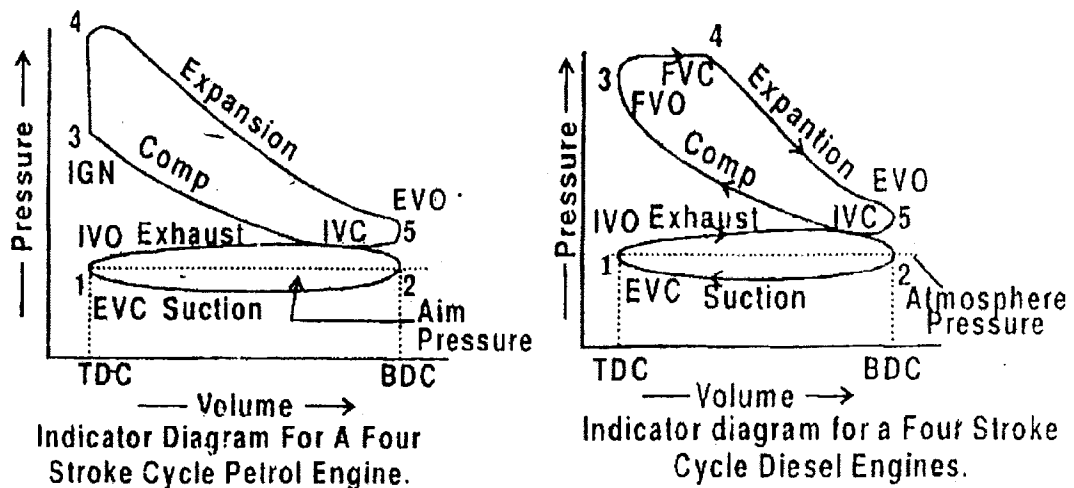
14. Draw the block diagram of a vapor compression refrigeration system and corresponding p-h and T-S diagram.

Answer:



17. Draw indicator diagram for four stroke SI and CI engine in T-S graph.

Answer:



18. For a material modulus of elasticity is 200GPa and Possion's ratio is 0.3. Find modulus of rigidity and bulk modulus.

Solution: We know that modulus of rigidity,

$$C = \frac{m \cdot E}{2(m + 1)}$$

Here, $E = 200 \text{ GPa}$ and $\frac{1}{m} = 0.3$ or, $m = 3.33$,

So,
$$C = \frac{3.33 \times 200}{2(3.33 + 1)} = 76.90 \text{ GPa (Answer)}$$

Again,
$$K = \frac{m \cdot E}{3(m - 2)}$$

$$\Rightarrow K = \frac{3.33 \times 200}{3(3.33 - 2)} = 166.91 \text{ GPa (Answer)}$$

19. An air compressor takes in air at 1 bar and 20°C and compresses it according to law $p v^{1.2} = \text{constant}$. It is then delivered to a receiver at a constant pressure of 10 bar. $R = 0.287 \text{ kJ/kg K}$. Determine (i) Temperature at the end of compression (ii) Workdone.

Solution:

Here, Initial pressure, $P_1 = 1 \text{ bar}$

Initial temperature, $T_1 = 20 + 273 = 293 \text{ K}$; Final pressure, $P_2 = 10 \text{ bar}$

(i) Final temperature:

Using the relation,
$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}}$$

$$\Rightarrow \frac{T_2}{293} = \left(\frac{10}{1} \right)^{\frac{1.2-1}{1.2}}$$

$$\Rightarrow T_2 = 293 \times \left(\frac{10}{1} \right)^{\frac{1.2-1}{1.2}} = 430 \text{ K} = 157^\circ \text{C. (Answer)}$$

(ii) Work done:

We know,
$$W = m R T_1 \frac{n}{n-1} \left[\left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right]$$

$$= 1 \times 0.287 \times 293 \times \frac{1.2}{1.2-1} \times \left[\left(\frac{10}{1} \right)^{\frac{1.2-1}{1.2}} - 1 \right] = 236.13 \text{ KJ/Kg of air (Answer)}$$

20. Write Bernoulli's equation for real fluid and indicate every term. Is it an energy equation you think? If Yes, then explain.

Answer: Bernoulli's Equation:

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 + h_f$$

Here, $\frac{P_1}{\gamma}$ = pressure energy per unit weight of fluid or pressure head,

$\frac{V_1^2}{2g}$ = Kinetic energy per unit weight or kinetic head

Z = potential energy per unit weight or potential head and h_f = head due to friction loss.

The Bernoulli Equation can be considered a statement of the conservation of energy principle appropriate for flowing fluids. The qualitative behavior that is usually labeled with the term "Bernoulli effect" is the lowering of fluid pressure in regions where the flow velocity is increased. This lowering of pressure in a constriction of a flow path may seem

counterintuitive, but seems less so when you consider pressure to be energy density. In the high velocity flow through the constriction, kinetic energy must increase at the expense of pressure energy.

21. Draw a steam turbine power plant and the Rankine cycle T-S diagram.

Answer:

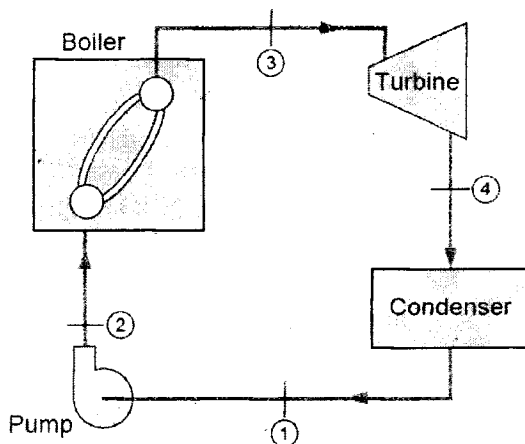


Figure: Simple steam power plant that operates on the Rankine cycle

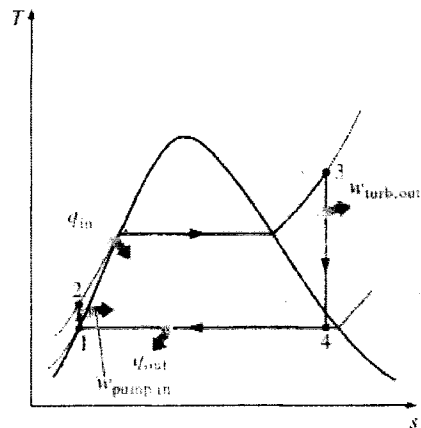
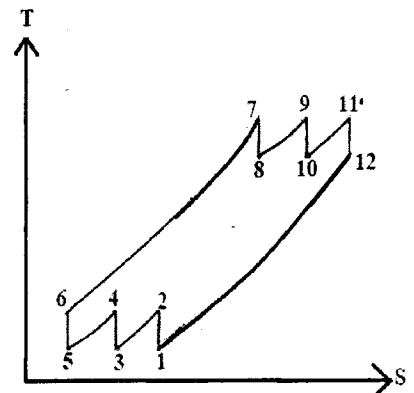
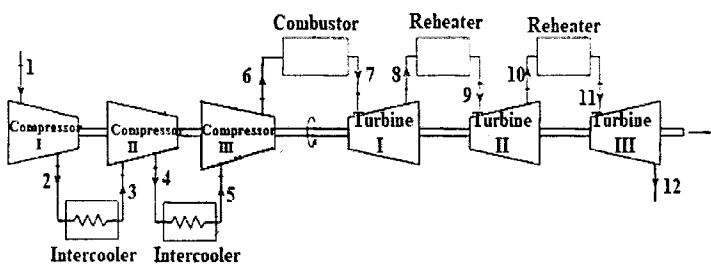


Fig.: T-S diagram of Rankine cycle

22. Draw a T-S diagram for an open cycle gas turbine of 2 stage reheating and 2 stage intercooling.

Answer:



23. Draw a Wheatstone bridge circuit. How it measures the strain?

Answer: A fundamental parameter of the strain gage is its sensitivity to strain, expressed quantitatively as the gage factor (GF). Gage factor is defined as the ratio of fractional change in electrical resistance to the fractional change in length (strain):

$$GF = \frac{\Delta R/R}{\Delta L/L} = \frac{\Delta R/R}{\epsilon}$$

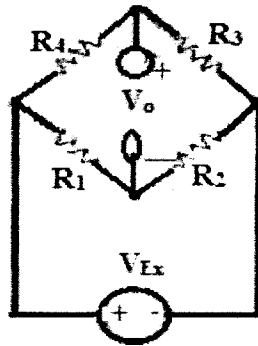


Figure 3. Wheatstone bridge

The output voltage of the bridge, V_o , is equal to:

$$V_o = \left[\frac{R_3}{R_3 + R_4} - \frac{R_2}{R_1 + R_2} \right] \cdot V_{EX}$$

Therefore, if R_4 is replaced in Figure 3 with an active strain gage, any changes in the strain gage resistance will unbalance the bridge and produce a nonzero output voltage. If the nominal resistance of the strain gage is designated as R_G , then the strain-induced change in resistance, ΔR , can be expressed as $\Delta R = R_G \cdot GF \cdot \epsilon$, from the previously defined Gage Factor equation. Assuming that $R_1 = R_2$ and $R_3 = R_G$, the bridge equation above can be rewritten to express V_o/V_{EX} as a function of strain (see Figure 4). Note the presence of the $\frac{1}{(1+GF \cdot \frac{\epsilon}{2})}$ term that indicates the nonlinearity of the quarter-bridge output with respect to strain.

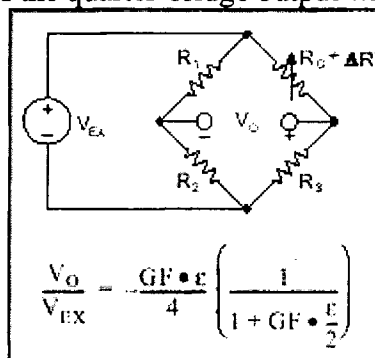


Figure 4. Quarter-Bridge Circuit

24. Write the significance of Froude Number, Reynolds Number and Nusselt number.

Answer:

Froude Number: The Froude number is a dimensionless number defined as the ratio of a characteristic velocity to a gravitational wave velocity.

The Froude number is defined as:

$$Fr = \frac{V}{c}$$

where V is a characteristic velocity, and c is a characteristic water wave propagation velocity. The Froude number is thus analogous to the Mach number. The greater the Froude number, the greater the resistance.

Reynolds Number: It is defined as the ratio of the inertia force to the viscous force. i.e.,

$$Re = \frac{\text{Inertia Force}}{\text{Viscous Force}} = \frac{\rho VD}{\mu} = \frac{VD}{\nu}$$

Significance:

- Reynolds number signifies the relative predominance of the inertia to the viscous forces occurring in the flow systems.
- Higher the Reynolds number the greater will be the relative contribution of inertia effect. Smaller the value of Re, the greater will be the relative magnitude of the viscous stresses.
- Reynolds number is taken as an important criterion of kinematic and dynamic similarities in forced convection heat transfer.
- It indicates that the flow is laminar or turbulent. For pipe flow if $Re < 2000$, the flow is laminar, if $Re > 4000$, the flow is turbulent. If $2000 < Re < 4000$ it is transition.

Nusselt Number (Nu): It is the ratio of heat flow rate by convection process under a unit temperature gradient to the heat flow rate by conduction process under a unit temperature gradient through a stationary thickness of L meters. i.e.,

$$Nu = \frac{hL}{K}$$

Significance:

- The Nusselt number represents the enhancement of heat transfer through a fluid layer as a result of convection relative to conduction across the same fluid layer.
- The larger the Nusselt number, the more effective the convection.
- A Nusselt number of $Nu = 1$ for a fluid layer represents heat transfer across the layer by pure conduction.

Ashuganj Power Station Company Ltd. (APSCL)

Post: Assistant Engineer(Mechanical)

Time-10.00AM to 11.30AM

Date:06.05.2016

Exam Hall: ECE Building, BUET

[Technical Question Only]

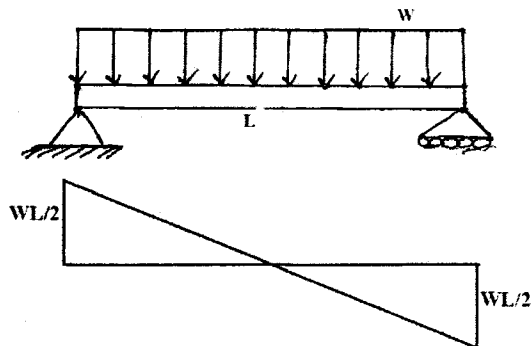
11. Two gears A and B mesh with each other. The speed of gear A is 795rpm. Number of teeth of the two gears A and B are respectively 50 and 20. Find speed of gear B.

Solution:

Given, $N_A = 795$ rpm; $T_A = 50$; $T_B = 20$; $N_B = ?$

We get, $\frac{N_B}{N_A} = \frac{T_A}{T_B}$

$\therefore N_B = \frac{50}{20} \times 795 = 1987.5$ rpm (Answer)

12. Draw SFD of this beam.**Answer:**

13. A boiler produces steam of enthalpy 2620KJ/Kg with the feed water of enthalpy 270KJ/Kg. If the steam rate 50Kg/hr then find the steam generation factor and the boiler power in KW. The latent heat of evaporation is 2257KJ/Kg.

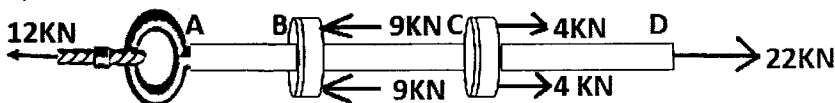
Solution:

Given, $h = 2620 \text{ KJ/Kg}$; $h_f = 270 \text{ KJ/Kg}$; $m = 50 \text{ Kg/hr}$; $l_v = 2257 \text{ KJ/Kg}$;

We get, Steam Generation factor $= \frac{h - h_f}{2257} = \frac{2620 - 270}{2257} = 1.04 \text{ (Answer)}$

Boiler Power $= m(h - h_f) = \frac{50}{3600} (2620 - 270) = 32.36 \text{ KW (Answer)}$

14. A rectangular steel bar has width of 35mm and thickness is 10mm. Find the stress at the section AB, BC and CD.

**Solution:**

For the section AB, we get,



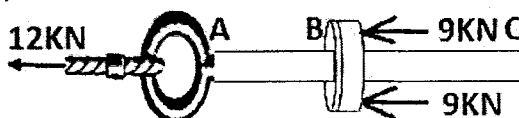
Here,

$$\text{Area, } A = 35 \times 10 = 350 \text{ mm}^2 = 350 \times 10^{-6} \text{ m}^2$$

$$P_{AB} = 12 \text{ kN} = 12 \times 10^3 \text{ N}$$

$$\therefore \sigma_{AB} = \frac{P_{AB}}{A} = \frac{12 \times 10^3}{350 \times 10^{-6}} = 34.28 \text{ MPa (Answer)}$$

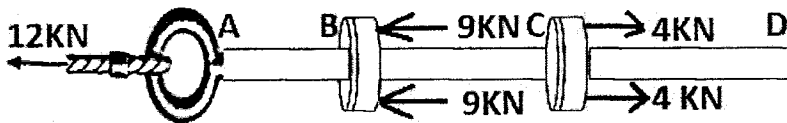
For section AC, We get,



$$P_{AC} = 12 + 9 + 9 = 30 \text{ kN}$$

$$\sigma_{AC} = \frac{P_{AB}}{A} = \frac{30 \times 10^3}{350 \times 10^{-6}} = 85.71 \text{ MPa (Answer)}$$

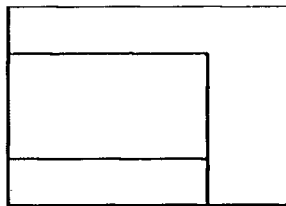
For section AD, We get,



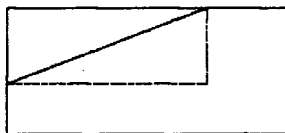
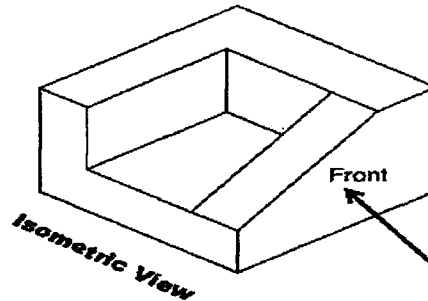
$$P_{AD} = 12 + 9 + 9 - 4 - 4 = 22 \text{ kN}$$

$$\sigma_{AD} = \frac{P_{AD}}{A} = \frac{22 \times 10^3}{350 \times 10^{-6}} = 62.85 \text{ MPa (Answer)}$$

15. Draw Top view and Front view.



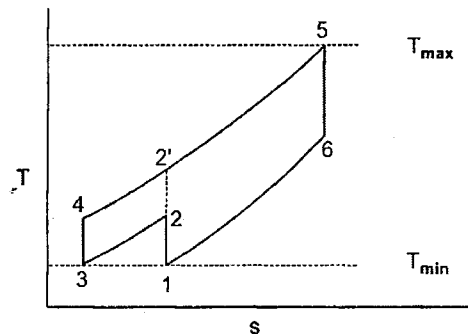
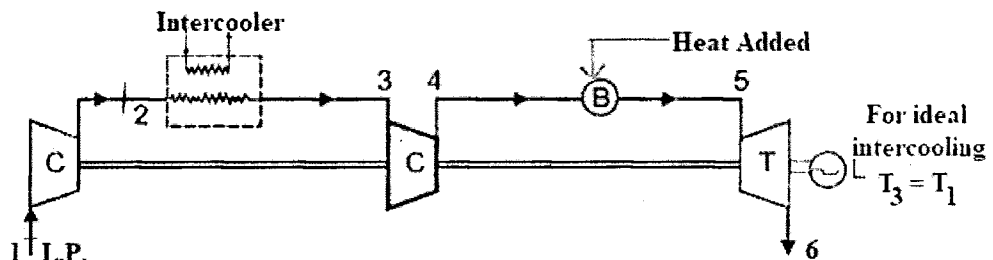
Top View



Front View

16. Draw the schematic diagram of a gas turbine with two compressors and intercooling with corresponding T-S diagram.

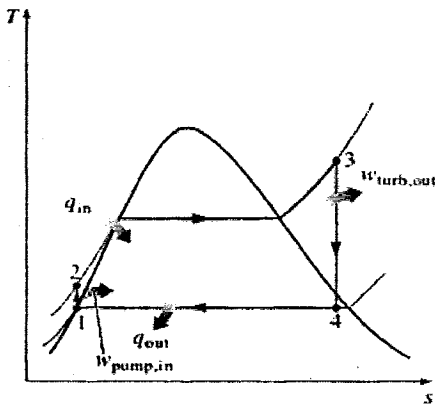
Answer:



17. Draw T-S diagram of Rankine cycle mentioning all processes and corresponding equipment.

Solution:

The T-S Diagram of Rankine cycle is shown below:



- 1-2 Isentropic compression in a pump
- 2-3 Constant pressure heat addition in a boiler
- 3-4 Isentropic expansion in a turbine
- 4-1 Constant pressure heat rejection in a condenser

18. A sling hygrometer shows the dry bulb temperature and wet bulb temperature is same and that is 32°C. Find the i) Relative humidity, ii) Wet bulb depression and iii) dew point temperature.

Solution: Since, the dry bulb and wet bulb temperature is same

So, (i) Relative Humidity, $R = \frac{f}{F} = 100\%$ (Answer)

(ii) Wet bulb depression = Dry bulb temperature – wet bulb temperature
= 0 (Answer)

(iii) Dew point temperature = 32°C (Answer)

19. A refrigerator makes 300 Kg (not exact value) water of 0°C into ice of 0°C by ½ hour. The latent heat is 335.33KJ/Kg. Find the capacity of the refrigerator in ton.

Answer: Here, $m = 300$ Kg, $l_f = 335.33$ KJ/Kg; Time = 0.5 hr

$$\begin{aligned} \therefore \text{Capacity} &= \frac{ml_f}{0.5 \times 60} \\ &= \frac{300 \times 335.33}{0.5 \times 60} = 3353.3 \text{ KJ/min} \\ &= 15.96 \approx 16 \text{ TOR (Answer)} \end{aligned}$$

20. A 3-phase connection has line voltage 400V and current is 35amp. The connected load is 20kW; determine the power factor of this line.

Solution:

Here, $\phi = 3$; $V = 400$ V; $I = 35$ A; $P = 20$ KW = 20000 W; $\cos\theta = ?$

We get, $P = \sqrt{3} VI \cos\theta$

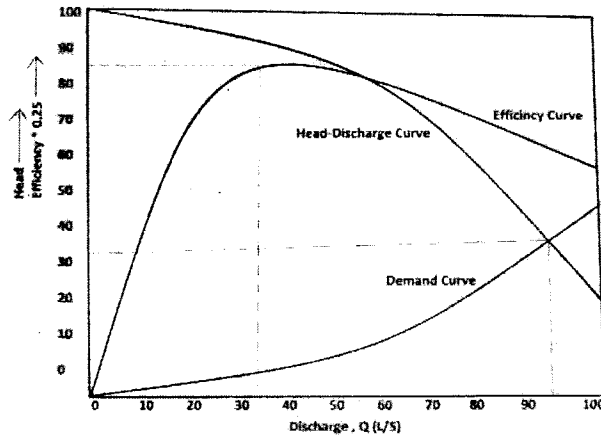
$$\Rightarrow \cos\theta = \frac{P}{\sqrt{3} VI} = \frac{20000}{\sqrt{3} \times 400 \times 35}$$

\therefore power factor = 0.8247 (Answer)

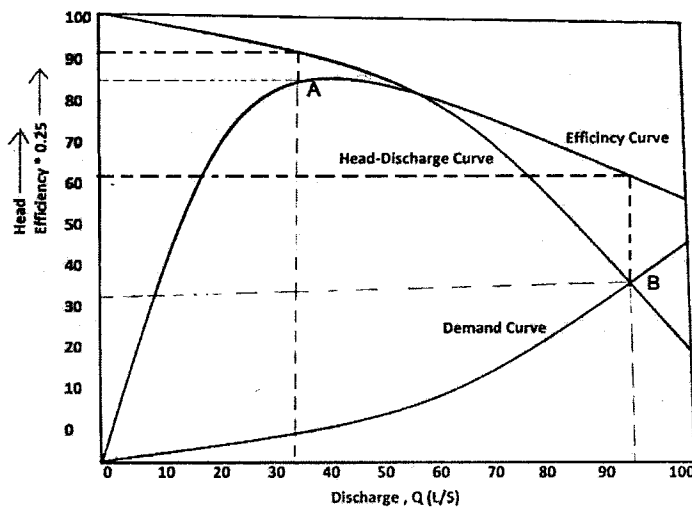
21. A generator's rotor speed is 750rpm and frequency is 50Hz. Calculate the number of poles.

Solution: We get, $P = \frac{120f}{N} = \frac{120 \times 50}{750} = 8$ (Answer)

22. The graph shown the head, efficiency versus discharge curve of a centrifugal pump. Find the design head, discharge and efficiency; Find also the operating Head and discharge. (Similar image is attached)



Solution:



From the Graph Point A is design point and B is the operating point.

For Design Point A:

Head = 90 m of water, discharge = 34 L/S, efficiency = $88 \times 0.25 = 22\%$;

For Operating Point B:

Head = 33m of water, discharge = 95 L/S, efficiency = $62 \times 0.25 = 15.5\%$;

1. Fillet and chamfering is done for- **reduce stress concentration**
2. Hydraulic system is based on- **Pascal's law**
3. Which type of turbine used in kaptai- **Kaplan**
4. Ratio of longitudinal and hoop stress- $\frac{1}{2}$
5. A simple truss is made by minimum _____ members. Answer: 3; if it says minimum force then Answer- 2.
6. The fluid state after throttling – **liquid and vapor**

7. Chiller is used in central air conditioning unit- cools the water
8. Maximum normal stress theory and Maximum shear stress theory- For brittle and ductile respectively.

Non-Departmental

Correct spelling

Empower, embolden, impound, blacken

Chief justice of Nepal- shushila karki

“Sobnom”- Syed mujtoba ali

Mustafizur in IPL - sunrisers hyderabad

PFA award by player choice- riad mahrez

Richshaw- Japanese

Pawruti- portugiz

Bangla goddya started- adhunik era

Bonuful- bolai chad

Ashuganj Power Station Company Limited (APSCL)

Post: Assistant Engineer(Mechanical)

Date:2010

Exam Hall: BUET

1. What is boiler mountings and accessories? Name 3 mountings and accessories.

Answer: Mountings: Mountings are required for proper and safe functioning of the boiler which are generally mounted over the boiler shell.

Example: 1. Water level indicator, 2. Pressure Gauge and 3. Safety valves

Accessories: These are the devices which are used as integral parts of boiler and help in running efficiently.

Example: 1. Super heater, 2.Economiser and 3. Air Preheater

2. What is fouling factor? What is the importance of it at the design of boiler?

Answer: During operation the heat and mass carrying tube surface gets covered by deposits of ash, soot, dirt and scale etc. This phenomenon of rust formation and deposition of fluid impurities is called fouling. It is difficult to ascertain the thickness and thermal conductivity of scale deposits, the effect of scale on heat flow is considered by specifying an equivalent scale heat transfer coefficient h_s . The reciprocal of heat transfer coefficient h_s is called the fouling factor, R_f .

$$R_f = \frac{1}{h_f} = \frac{1}{U_{dirt}} - \frac{1}{U_{clean}}$$

3. Define Ton of refrigeration and COP?

Answer: Ton of refrigeration: 1 tonne of refrigeration is the rate of heat removal required to freeze a metric ton (i.e., 1000 kg) of water at 0°C in 24 hours. Based on the heat of fusion being 333.55 kJ/kg,

1 tonne of refrigeration = 13,898 kJ/h = 3.861 kW

Coefficient of Performance (COP)

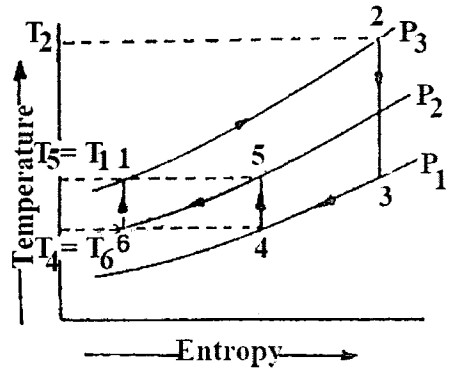
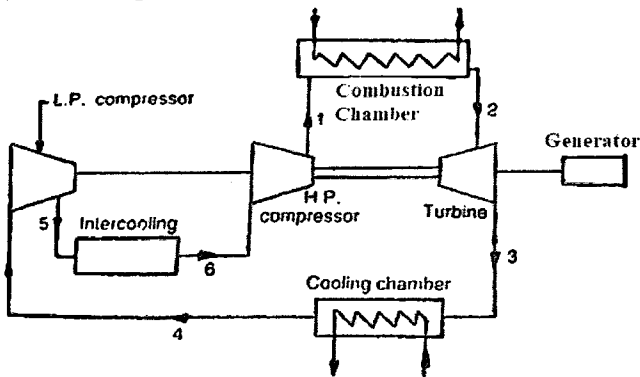
The Coefficient of Performance for a refrigerator is defined as the ratio of the refrigerating effect (cooling load, Q_R) to the work added (compressor power input, W_c) of the system,

i.e. $COP = Q_R / W_C$. [Q_R Expressed in ton and W_C in kW]

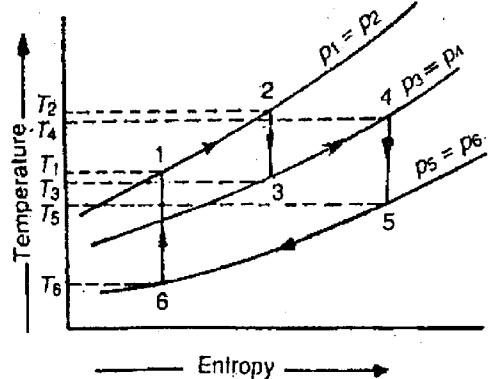
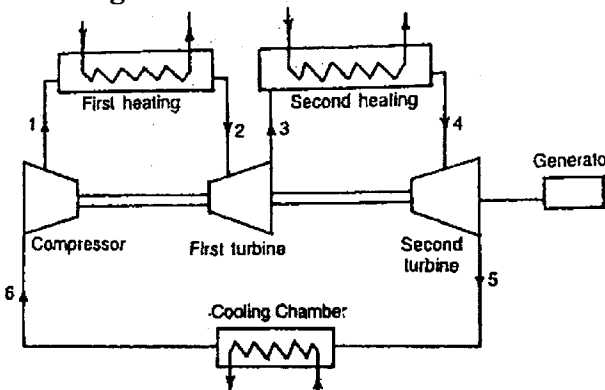
4. Draw schematic diagram of closed cycle gas turbine & corresponding T-S diagram for single stage inter cooling and single stage heating chamber.

Answer:

Intercooling



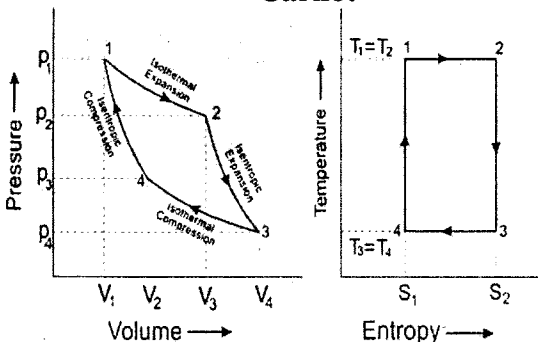
Reheating



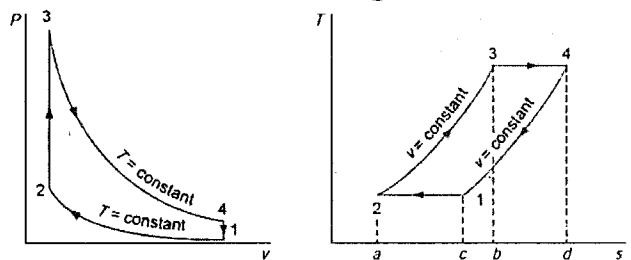
4. Draw P-V and T-S diagram of Carnot and Stirling Cycle.

Answer:

Carnot



Stirling



6. What is priming? How it is done?

Answer: Priming of centrifugal pump: priming of a centrifugal pump is defined as the operation in which the suction pipe, casing of the pump and a portion of the delivery pipe upto the delivery valve is completely filled up from outside source with the liquid to be raised by the pump before starting the pump. Thus the air from these parts of the pump is removed and these parts are filled with the liquid to be pumped. When the pump is running in air, the head generated is in terms of metre of air. If the pump is primed with water, the head generated is same metre of water. But as the density of air is very low, the generated head of air in terms of equivalent metre of water head is negligible and hence the water may not be sucked from the pump. To avoid this difficulty, priming is necessary.

7. Draw the diagram for counter flow and parallel flow heat exchanger.

Answer:

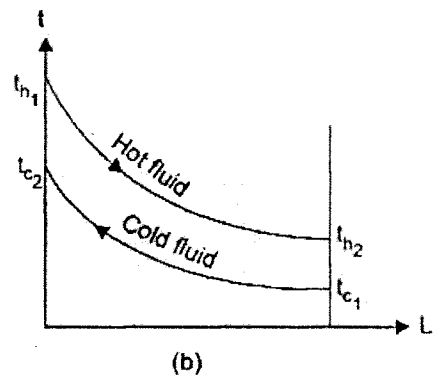
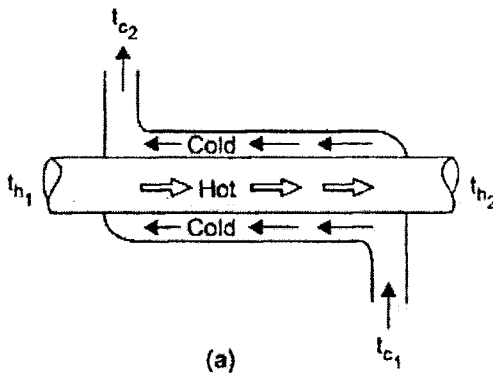


Fig. Counter-flow heat exchanger.

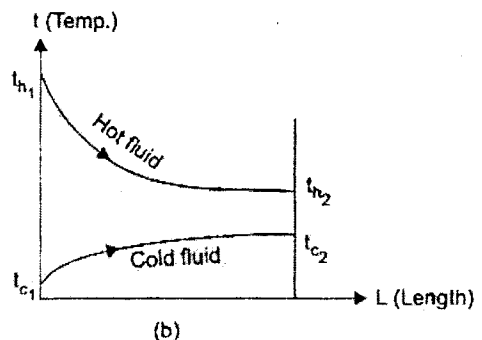
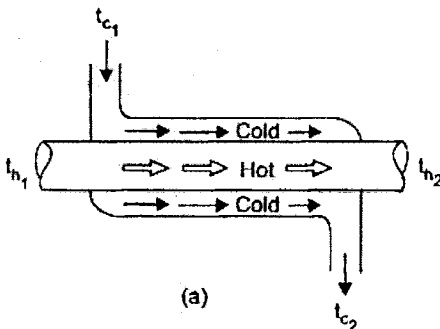


Fig. Parallel-flow heat exchanger.

8. Write the Bernoulli's equation for real and ideal fluid. What is Newtonian Fluid? Give example.

Answer: Bernoulli's equation for ideal fluid: $\frac{p}{\gamma} + \frac{v^2}{2g} + z = \text{constant}$

Where, p = pressure; v = velocity of fluid

z = datum energy; γ = specific weight = ρg

$\frac{p}{\gamma}$ = pressure energy; $\frac{v^2}{2g}$ = kinetic energy

For real fluid, $\frac{p_1}{\gamma} + \frac{v_1^2}{2g} + Z_1 = \frac{p_2}{\gamma} + \frac{v_2^2}{2g} + Z_2 + h_f$

Newtonian Fluid: Fluids which obey the Newton's law of viscosity ($\tau = \frac{du}{dy}$) are known as Newtonian fluids. Water, oil, gasoline, alcohol and even glycerin are examples of Newtonian fluids.

9. A cylinder is of bore 80mm & 100mm stroke. If the clearance volume $1 \times 10^{-4} \text{ m}^3$, what is air standard efficiency?

Solution: Given, $D = 80\text{mm}$, $L = 100\text{mm}$, $V_c = 1 \times 10^{-4} \text{ m}^3$

Stroke volume, $V_s = \frac{\pi}{4} \times 0.08^2 \times 0.1 = 5.03 \times 10^{-4} \text{ m}^3$

\therefore Compression Ratio $= \frac{V_c + V_s}{V_c} = \frac{5.03 + 1}{1} = 6.03$

\therefore Air standard efficiency, $= 1 - \frac{1}{r^{\gamma-1}} = 1 - \frac{1}{6.03^{1.4-1}} = 0.5126 = 51.26\%$ (Answer)

10. A plant capacity is 950MW and produced 567000 MW-hr/month. Peak load is 1000MW. Find (i) Load factor (ii) Plant capacity factor.

Solution: Average Load $= \frac{56700}{30 \times 24} = 787.5 \text{ MW}$

\therefore Load Factor $= \frac{\text{Average Load}}{\text{Maximum demand}} = \frac{787.5}{1000} = 0.7875$ (Answer)

And Plant capacity factor $= \frac{\text{Average Load}}{\text{Plant Capacity}} = \frac{787.5}{950} = 0.83$ (Answer)

11. Draw the P-V and T-S diagram for Steam Turbine.

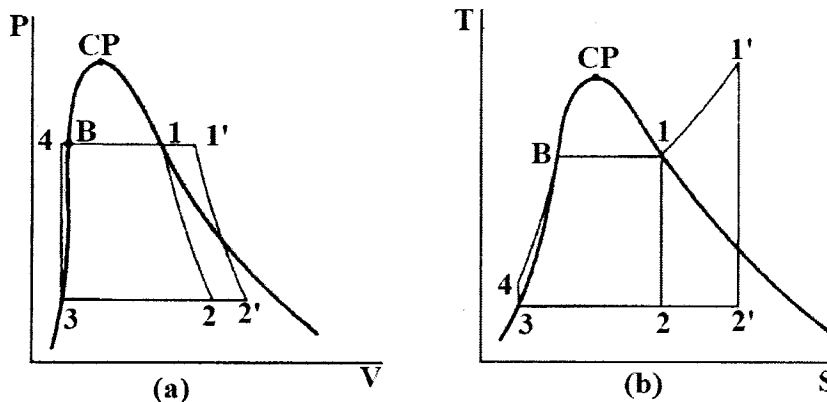


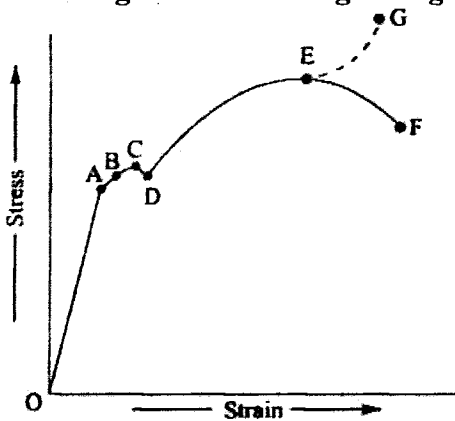
Fig.: Ideal Rankine cycles of the (a) P-V and (b) T-S diagrams. Line 1-2-3-4-B-1 = saturated cycle. Line 1'-2'-3-4-B-1' = superheated cycle. CP = Critical point

12. A math relates with Bernoulli's equation and pump power and efficiency.

13. Drawing.

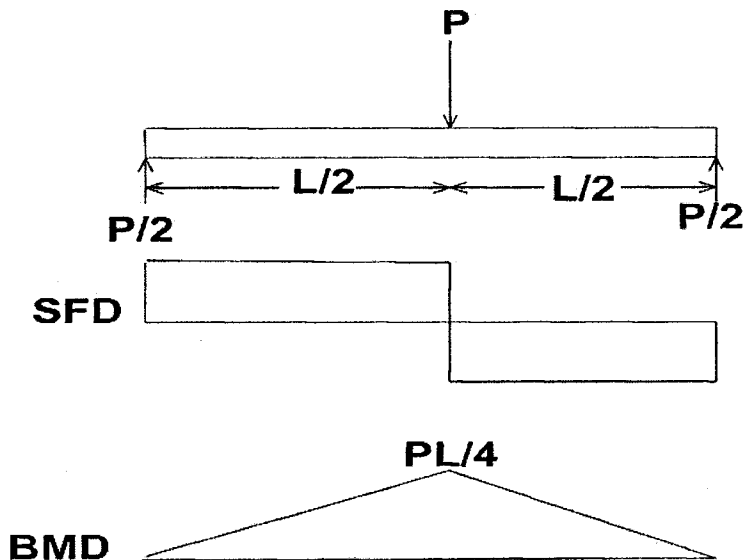
Bangladesh Power Development Board (BPDB)-2010

1. Draw the typical stress-strain diagram of mild steel showing yield strength, ultimate strength and breaking strength on it.



- A- Proportional limit
 B- Elastic limit
 C- Upper yield point
 D- lower yield point
 E- Ultimate stress/strength
 F- Breaking stress/strength
 G- Actual Rupture Strength

2. A concentrated load P is applied at the midspan of a simply supported beam of length L . Draw the shear force and bending moment diagrams of the beam showing peak values.



3. A steel rod of 1 cm^2 in cross-sectional area and 10 cm long is subjected to an axial pull of 2000 kgf. Find the elongation of the rod considering $E=200 \text{ GPa}$.

Solution: Here, Area, $A = 1 \times 10^{-4} \text{ m}^2$; $L = 0.1 \text{ m}$; $P = 2000 \text{ Kg} = 2000 \times 9.81 = 19620 \text{ N}$ and $E = 200 \times 10^9 \text{ Pa}$

$$\text{We know, } \delta = \frac{PL}{AE} = \frac{19620 \times 0.1}{1 \times 10^{-4} \times 200 \times 10^9} = 9.81 \times 10^{-5} \text{ m} = 0.00981 \text{ cm (Answer)}$$

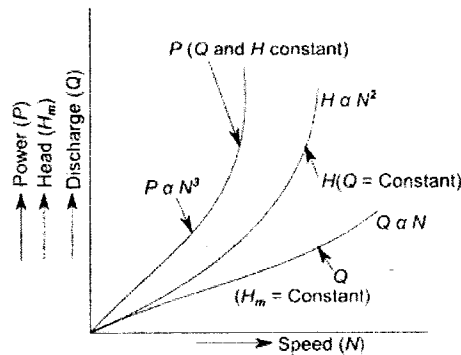
4. Write down the Bernoulli's equation for ideal and real fluid.

Answer: Bernoulli's Equation for ideal fluid,

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2$$

$$\text{For real fluid, } \frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 + h_f$$

5. Draw the performance characteristics curves of a centrifugal pump.



Main characteristics curves of a pump.

6. A centrifugal pump is used to raise water at a height of 100 ft with discharge of 2.0 cusec. The efficiency of the pump is 62%. Find the input horse power of the pump.

Solution: Given, $H=100\text{ft}=30.48\text{ meter}$; $Q=2.0\text{ cusec}=0.057\text{ m}^3/\text{sec}$; $\eta=62\%$;

$$\rho = 1000\text{ Kg/m}^3$$

$$\begin{aligned}\text{We get, } P &= \rho g Q H / \eta \\ &= (1000 \times 9.81 \times 0.057 \times 30.48) / 0.62 \\ &= 27.5\text{ KW} \\ &= 36.88\text{ hp (Answer)}\end{aligned}$$

7. Define “ton of refrigeration”.

Answer: Tonne of refrigeration/TR:

A tonne of refrigeration is defined as the amount of refrigeration effect produced by the uniform melting of one tonne (1000kg) of ice from and at 0 degree centigrade in 24 hours.

$$1\text{TR}=210\text{ kJ/min}=3.5\text{ kW}$$

8. What are the functions of an economizer and safety valve in a boiler?

Answer: Economizer:

An economizer is a device used to heat feed water by utilizing the heat in the exhaust flue gases before leaving through the chimney. As the name indicates, the economizer improves the economy of the steam boiler.

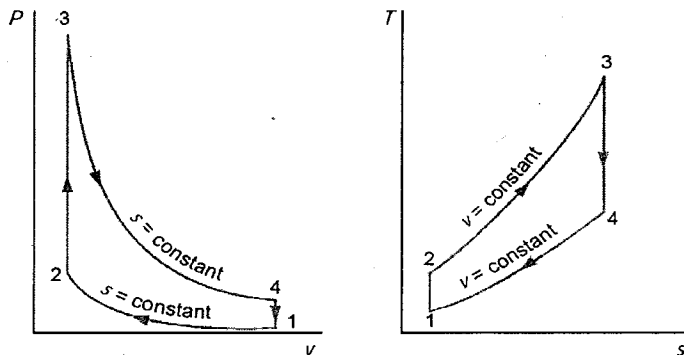
Safety Valve

- The safety valve (pressure relief valve) is used in a boiler to relieve the pressure of steam when it is above the working pressure.
- Its function is to discharge a portion of the steam from the boiler automatically when the steam pressure exceeds the normal limit. It is mounted on the top of the shell.
- As per boiler regulation two safety valves are required to be fitted in each boiler.

9. Draw P-V and T-S diagram of Otto cycle and Diesel cycle.

Otto Cycle:

Otto cycle consists of two isentropic and two isochoric processes. Heat is supplied and heat is rejected by the cycle during isochoric process.



Pressure-volume and Temperature-entropy diagram for the air-standard Otto cycle

Where,

1-2: Adiabatic compression

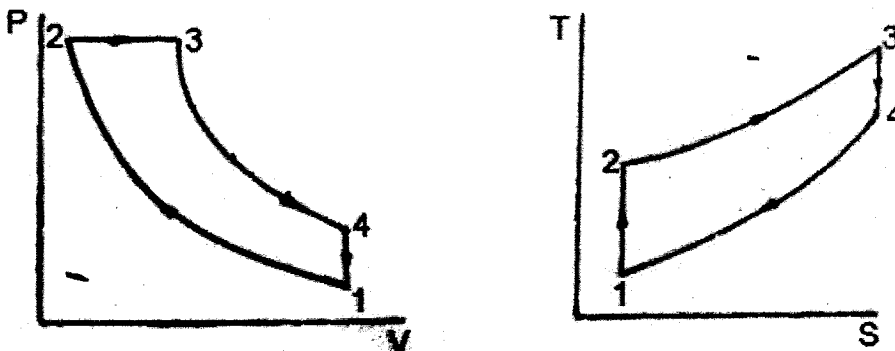
2-3: Isochoric/constant volume heat addition

3-4: Adiabatic expansion

4-1: Isochoric heat rejection

Diesel Cycle:

The air-standard diesel cycle is shown on p-V and T-s diagrams respectively. This is the ideal cycle for the diesel engine, which is also called the compression ignition engine. This cycle consists of two reversible adiabatic, one reversible isobaric and one reversible isochoric process.



Pressure-volume and Temperature-entropy diagram for the air-standard Diesel cycle

Basic processes in diesel cycle

1-2; Reversible adiabatic compression

2-3: Constant pressure heat addition

3-4: Reversible adiabatic expansion

4-1: Constant volume heat rejection

10. How do you identify a petrol engine and a diesel engine?

Answer: Diesel engines are compression ignition and petrol engines are spark ignited one. If there is a spark plug its petrol engine or else it would be diesel engine. The presence of fins in the engine compartment also differentiates them apart as Diesel engines have and petrol does not.

Encircle the most appropriate answer. 10 × 1 = 10

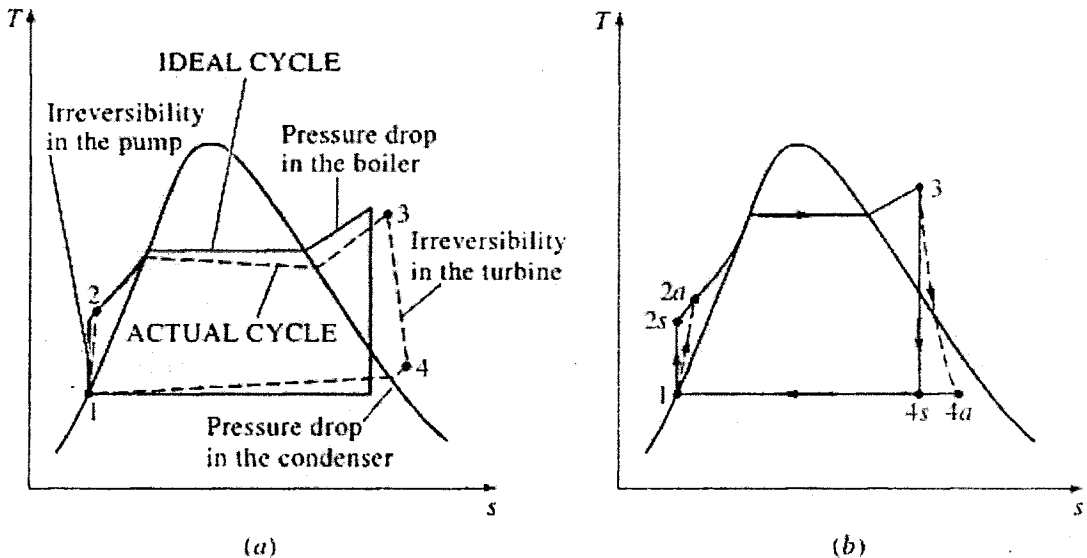
11. In a thin-walled pressure cylinder the ratio of longitudinal stress to the hoop stress is
a. **0.5** b. 2.0 c. 1.0 d. 4.
12. A loaded column fails due to
a. stress due to direct load b. stress due to bending load
c. **both (a) and (b)** d. none of the above
13. Every cross-section of a shaft, which is subjected to a twisting moment, is under
a. compressive stress
b. **shear stress**
c. tensile stress d. bending stress
14. If a member is subjected to an axial tensile load, the plane inclined at 45° to the axis of loading carries
a. minimum shear stress b. maximum shear stress
c. minimum normal stress d. **maximum normal stress**
15. Continuity equation deals with the law of conservation of
a. **mass**
b. energy
c. momentum
d. none of the above
16. Which of the following pump is a positive displacement type?
a. centrifugal pump
b. **reciprocating pump**
c. axial flow pump
d. mixed flow pump
17. Compression ratio of diesel engine varies from
a. 6 to 10 b. 10 to 15 c. **15 to 25** d. 25 to 30
18. Which is not the mounting in a boiler?
a. safety valve b. **superheater**
c. fusible plug d. water level indicator
19. What should be the relative humidity when the dry bulb and wet bulb temperature are same?
a. 50 %
b. 75 %
c. **100 %**
d. 0 %
20. The objective of a flywheel in an engine is to
a. perform balancing
b. increase the power generation
c. **reduces energy fluctuation**
d. increase energy fluctuation

Bangladesh Power Development Board (BPDB)-2015

1. What is the deviation of Ideal Rankine cycle and actual Rankine cycle?

Answer:

As a result of irreversibility in various components such as fluid friction and heat loss to the surroundings, the actual cycle deviates from the ideal Rankine cycle.



2. Give the advantages and disadvantages of gas turbine over steam turbine.

Answer:

Advantages:

1. It is smaller in size and weight as compared to an equivalent steam power plant. For smaller capacities the size of gas turbine power plant is appreciably greater than a high speed diesel engine plant but for larger capacities it is smaller in size than a comparable diesel engine plant. If size and weight are the main consideration such as in ships, aircraft engines and locomotives, gas turbines are more suitable.
2. The initial cost and operating cost of the plant is lower than an equivalent steam power plant.
3. The plant requires less water as compared to a condensing steam power plant.
4. The plant can be started quickly, and can be put on load in a very short time.
5. There are no standby losses in the gas turbine power plant whereas in steam power plant these losses occur because boiler is kept in operation even when the turbine is not supplying any load.
6. The maintenance of the plant is easier and maintenance cost is low.

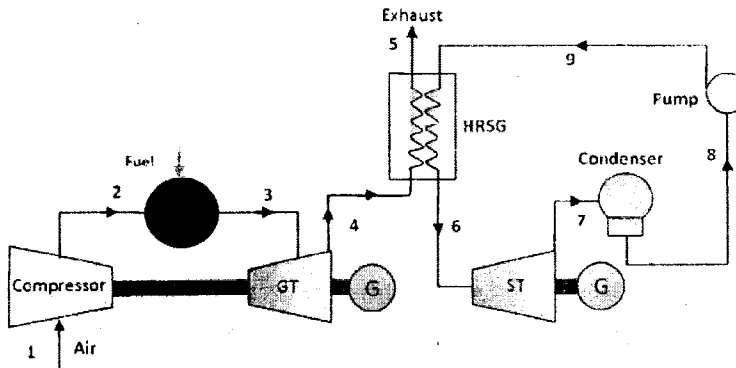
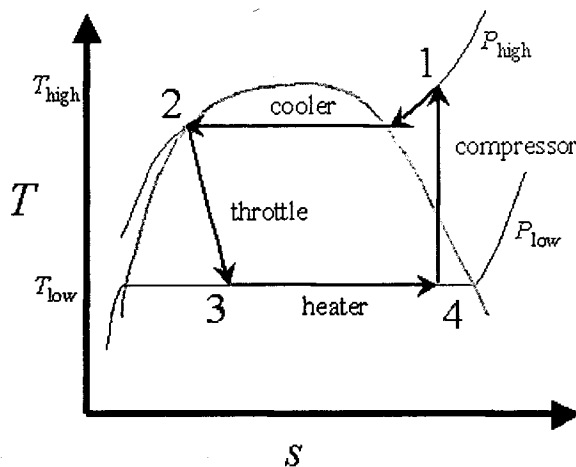
Disadvantages:

1. Major part of the work developed in the turbine is used to derive the compressor. Therefore, network output of the plant is low.
2. Since the temperature of the products of combustion becomes too high so service conditions become complicated even at moderate pressures.

3. Write the name of main components of a thermal power plant.**Answer:**

Main parts of the plant are

1. Coal conveyor 2. Stoker 3. Pulverizer 4. Boiler 5. Coal ash 6. Air preheater
7. Electrostatic precipitator 8. Smoke stack 9. Turbine 10. Condenser 11. Transformers 12. Cooling towers 13. Generator 14. High - voltage power lines

4. Draw a schematic diagram of combined cycle power plant.**5. Draw T-S diagram of vapor compression refrigeration system.****Answer:****6. A shaft is transmitted 50 hp, speed of the shaft is 400 rpm. What is the torque?****Solution:** Given that, $P = 50 \text{ hp} = 37.285 \text{ KW}$ $N = 400 \text{ rpm}$

$$\omega = \frac{2\pi N}{60} = \frac{2\pi \times 400}{60} = 41.88 \text{ rad/sec}$$

We get,

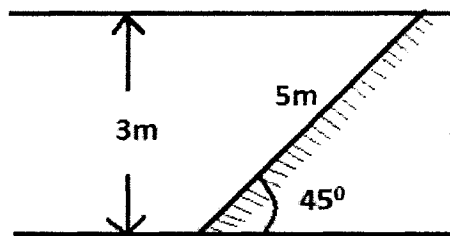
$$P = T \times \omega$$

$$\Rightarrow T = \frac{P}{\omega}$$

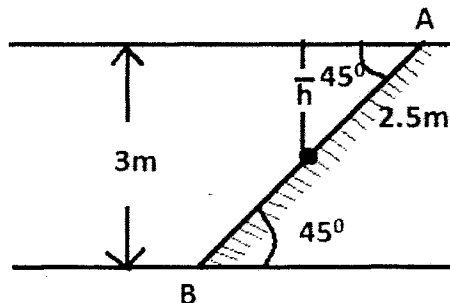
$$= \frac{37.285}{41.88}$$

$$\therefore T = 0.89 \text{ KN.m (Answer)}$$

7. Find the resultant force.



Solution:



Here, Area of the gate = $3 \times 5 = 15 \text{ m}^2$

$$\bar{h} = 2.5 \sin 45^\circ = 1.77 \text{ m}$$

\therefore Resultant Force, $F = \rho g \bar{h} A$

$$= 1000 \times 9.8 \times 1.77 \times 15 = 260.19 \text{ KN (Answer)}$$

8. Draw the SFD. (Cannot recall)

9. Find the efficiency of actual Brayton cycle. (Cannot recall)

10. Write short note on pyrometer, anemometer, tachometer and dynamometer.

Pyrometer: Pyrometer is an instrument for measuring temperature. The pyrometer can be applied to instruments that measure high temperature only, but some pyrometer is considered to measure low temperature. Thus, the temperature measurement under severe conditions is the most accurate method, and it is established on non-intrusive (indirect) temperature techniques. Temperature dependence of spectral intensity of light (Planck's law), i.e. the color of the light relates to the temperature of its source, range: from about -50°C to $+4000^\circ \text{C}$, note: measurement of thermal radiation (instead of thermal conduction, or thermal convection) means: no physical contact becomes necessary in temperature measurement (pyrometry).

Anemometer: An anemometer is an instrument that measures wind speed. This type of anemometer has a spinning wheel. The stronger the wind blows, the faster the wheel rotates. The anemometer counts the number of rotations, which is used to calculate wind speed.

Tachometer:

A tachometer (also called a revolution-counter, "Tach", rev-counter, or RPM gauge) is an instrument that measures the rotation speed of a shaft or disk, as in a motor or other machine. The device usually displays the revolutions per minute (RPM) on a calibrated

analogue dial, but digital displays are increasingly common. Tachometers or rev counters on automobiles, aircraft, and other vehicles show the rate of rotation of the engine's crankshaft, and typically have markings indicating a safe range of rotation speeds.

Dynamometer: A dynamometer or "dyno" for short, is a device for measuring force, moment of force (torque), or power. For example, the power produced by an engine, motor or other rotating prime mover can be calculated by simultaneously measuring torque and rotational speed (RPM). A dynamometer can also be used to determine the torque and power required to operate a driven machine such as a pump. In that case, a motoring or driving dynamometer is used. A dynamometer that is designed to be driven is called an absorption or passive dynamometer. A dynamometer that can either drive or absorb is called a universal or active dynamometer.

11. The graph showed the head, efficiency versus discharge curve of a centrifugal pump. Find the design head, discharge and efficiency; Find also the operating Head and discharge.

Solution: Same as question-22, Ashuganj Power Station Company Ltd. (APSCL)-2016.

Power Grid Company of Bangladesh (PGCB)-2013

1. Define homogeneous materials and isotropic materials; give an example each of them.

Answer:

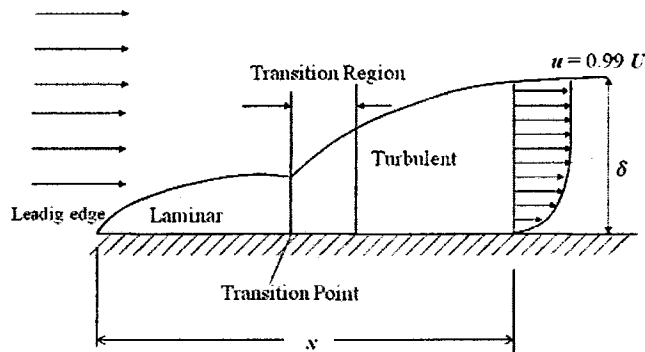
Homogeneous: A homogeneous material means a material which has uniform composition and uniform properties throughout. Plastics, ceramics, glass, metals, alloys, paper, board, resins, and coatings are examples of homogeneous materials. Air, salt solution, etc are examples of homogeneous mixtures. In addition, an alloy is a solid solution, which is a homogeneous solid mixture of two metals.

Isotropic: Isotropic means that the properties of materials are the same in all directions. In processes, the rate of process is the same in all directions. Glass and metals are examples of isotropic materials

2. What is boundary layer? Show different regimes of boundary layer for a flat plate.

Answer:

Boundary Layer: When a real fluid flows past a stationary solid boundary, a layer of fluid which comes in contact with the boundary surface adheres to it and condition of no slip occurs. Thus the layer of fluid which can't slip away from the boundary surface undergoes retardation, this retarded layer further causes retardation for the adjacent layers of the fluid, thereby developing a small region in the immediate vicinity of the boundary surface and approaches the velocity of main stream. The layer adjacent to the boundary is known as boundary layer.

Boundary Layer Profile For Flat Plate:

3. An elastic bar of cross section A and length L is held fixed at both ends. The bar has modulus of elasticity E and coefficient of thermal expansion α . Derive the expression for axial force due to temperature increase of ΔT . (Assume no buckling of the bar)

Solution: For a homogeneous bar mounted between unyielding supports as shown, the thermal stress is computed as:

Deformation due to temperature changes;

$$\delta_T = \alpha L \Delta T$$

Deformation due to equivalent axial stress;

$$\delta_P = \frac{PL}{AE} = \frac{\sigma L}{E}$$

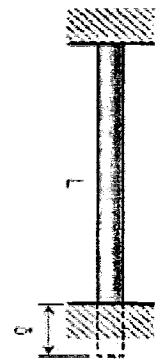
$$\Rightarrow \delta_T = \delta_P$$

$$\Rightarrow \alpha L \Delta T = \frac{\sigma L}{E}$$

$$\Rightarrow \sigma = E \alpha \Delta T$$

$$\therefore \text{Axial Force, } P = E \alpha \Delta T A$$

Where σ is the thermal stress in MPa and E is the modulus of elasticity of the bar in MPa.

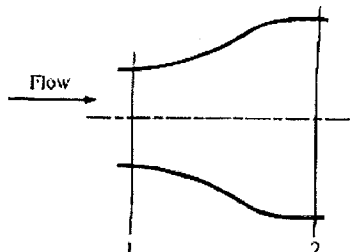


4. Find the maximum torsional shear stress in a solid shaft of diameter 10mm and the applied torque is 30 Nm.

Solution: Here, $T = 30 \text{ Nm}$; $D = 10 \text{ mm} = 0.01 \text{ m}$

$$\text{We get, } \tau_{\max} = \frac{16 T}{\pi D^3} = \frac{16 \times 30}{\pi \times (0.01)^3} = 152 \text{ MPa (Answer)}$$

5. In a diffuser water flow rate 8 Kg/s , area $A_1 = 7 \times 10^{-4} \text{ m}^2$ and $A_2 = 4 \times 10^{-3} \text{ m}^2$. Determine the increase in static pressure between section 1 and section 2. Assume water density is 1000 Kg/m^3 and the flow is frictionless.



Solution:

Given, $\dot{m} = 8 \text{ Kg/s}$; $A_1 = 7 \times 10^{-4} \text{ m}^2$ and $A_2 = 4 \times 10^{-3} \text{ m}^2$; $P_1 - P_2 = ?$

Here, $\dot{m} = A_1 V_1 \rho = A_2 V_2 \rho$

$$\therefore V_1 = \frac{\dot{m}}{A_1 \rho} = \frac{8}{7 \times 10^{-4} \times 1000} = 11.43 \text{ ms}^{-1}$$

$$\text{And, } V_2 = \frac{\dot{m}}{A_2 \rho} = \frac{8}{4 \times 10^{-3} \times 1000} = 2 \text{ ms}^{-1}$$

Applying Bernoulli's equation at (1) and (2), we get

$$\frac{p_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + z_2$$

$$\text{or, } \frac{p_1 - p_2}{\gamma} = \frac{v_2^2}{2g} - \frac{v_1^2}{2g} + z_2 - z_1$$

$$\text{or, } \frac{p_1 - p_2}{\gamma} = \frac{1}{2 \times 9.8} (2^2 - 11.43^2) + 0$$

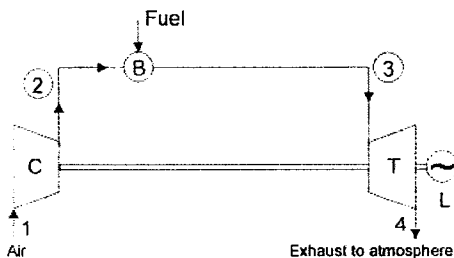
$$\text{or, } \frac{p_1 - p_2}{\gamma} = -6.46$$

$$\text{or, } p_2 - p_1 = 6.46 \times 9.8$$

$$\therefore p_2 - p_1 = 63.308 \text{ KPa (Answer)}$$

6. Draw the simple block diagram of open cycle gas turbine and the corresponding T-S diagram.

Answer:



C-Compressor

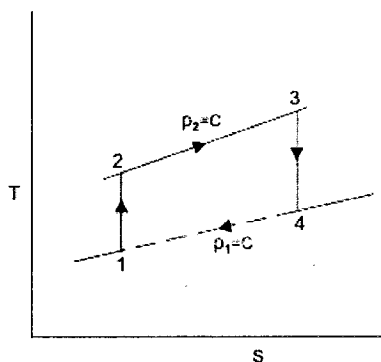
B-Burner or

Combustion

Chamber

T-Turbine

L- Load



7. What is cavitation? List two problems due to cavitation.

Answer:

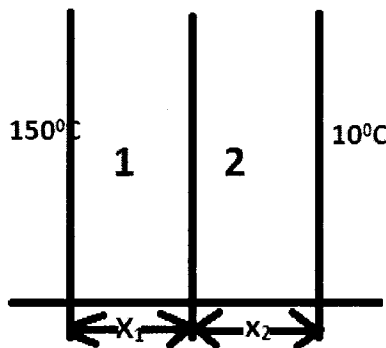
Cavitation: Cavitation is defined as the phenomenon of formation of vapor bubbles of a flowing liquid in a region where the pressure of the liquid falls below its vapor pressure and

the sudden collapsing of these vapor bubbles in a region of high pressure. When the vapor bubbles collapse, a very high pressure is created. The metallic surface, above which the liquid is flowing, is subjected to these high pressures, which cause pitting action on the surface. Thus cavities are formed on the metallic surface and also considerable noise and vibrations are produced.

Problems due to cavitation: the following effects of cavitation:

- i) The metallic surfaces are damaged and cavities are formed on the surfaces.
- ii) Due to sudden collapse of vapor bubble, considerable noise and vibrations are produced.

8. A composite wall of two 0.5m thick layers has a temperature 150°C on one side and 10°C on another side. Thermal conductivity of two layers are 0.05 W/mK and 0.5 W/mK respectively. Area of each side is 2m^2 . Find the overall thermal resistance of the wall and heat transfer per unit surface area.



Solution:

Given, $x_1 = x_2 = 0.5\text{m}$, $T_1 = 150^{\circ}\text{C}$, $T_2 = 10^{\circ}\text{C}$, $K_1 = 0.05 \text{ W/mK}$,

$K_2 = 0.5 \text{ W/mK}$, $A_1 = A_2 = 2\text{m}^2$

Overall Thermal resistance, $R_{th} = \frac{x_1}{K_1 A_1} + \frac{x_2}{K_2 A_2}$

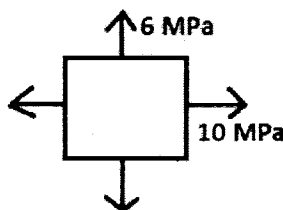
$$= \frac{0.5}{0.05 \times 2} + \frac{0.5}{0.5 \times 2}$$

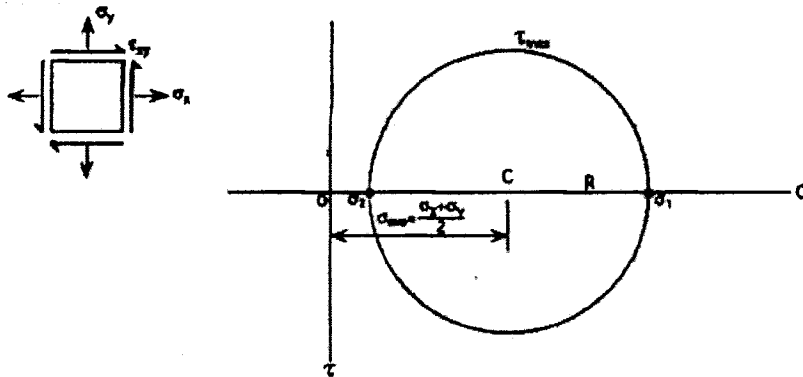
$$= 5 + 0.5 = 5.5 \text{ K/W (Answer)}$$

$$\text{Again, } Q = \frac{T_1 - T_2}{R_{th}}$$

$$= \frac{150 - 10}{5.5} = 25.45 \text{ W (Answer)}$$

9. For the plane stress shown in the stress element, draw the Mohr's circle to find the maximum in plane shearing stress and corresponding normal stress.



Solution:

Given, $\sigma_x = 10 \text{ MPa}$, $\sigma_y = 6 \text{ MPa}$, $\tau_{xy} = 0$

We get, $OC = \frac{\sigma_x + \sigma_y}{2} = \frac{10 + 6}{2} = 8 \text{ MPa}$

$$R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = \sqrt{\left(\frac{10 - 6}{2}\right)^2 + 0} = \pm 2 \text{ MPa}$$

\therefore Maximum shear stress = +2 and minimum shear stress = -2.

$$\begin{aligned} \text{Maximum Normal Stress, } \sigma_1 &= OC + R = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} \\ &= 8 + 2 = 10 \text{ MPa (Answer)} \end{aligned}$$

Minimum Normal Stress,

$$\sigma_2 = OC - R = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = 8 - 2 = 6 \text{ MPa (Answer)}$$

10. Compute the pressure drop when water flows at 3 L/s through a steel pipe with diameter and length 50mm and 40 m respectively. Assume density of water 1000 Kg/m³ and friction factor 0.02.

Solution:

Here, $Q = 3 \text{ L/s} = 3 \times 10^{-3} \text{ m}^3/\text{s}$, $d = 50 \text{ mm} = 0.05 \text{ m}$; $L = 40 \text{ m}$, $\rho = 1000 \text{ Kg/m}^3$; $f = 0.02$;

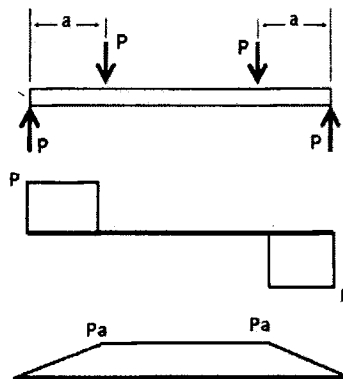
$$\text{We get, } Q = AV, \therefore V = \frac{Q}{A} = \frac{3 \times 10^{-3}}{\frac{\pi \times 0.05^2}{4}} = 1.527 \text{ ms}^{-1}$$

$$h_f = \frac{fV^2}{2gd} = \frac{0.02 \times 40 \times (1.527)^2}{2 \times 9.8 \times 0.05} = 1.903 \text{ m}$$

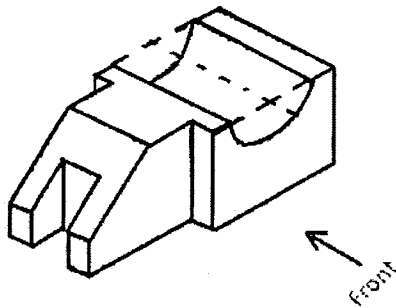
From the two end of the pipe,

$$\begin{aligned} \frac{P_1}{\gamma} &= \frac{P_2}{\gamma} + h_f \\ \Rightarrow \frac{P_1 - P_2}{\gamma} &= h_f \\ \Rightarrow P_1 - P_2 &= h_f \times \gamma \\ &= 1.903 \times 9.8 \\ &= 18.653 \text{ KPa (Answer)} \end{aligned}$$

11. Construct shear and bending moment diagrams showing peak values for the simply supported beam loaded with the forces shown in figure.



12. Draw the TOP VIEW and LEFT side VIEW.



[See the Similar drawing PGCB-2019]

Multiple Choice Questions:

- The physical mechanism of viscosity is one of _____ transfer.
 - Heat
 - Momentum**
 - Velocity
 - Particle
- Identify the correct statement.
 - Petrol engine draws a mixture of diesel and air during suction stroke
 - Diesel engine has lower compression ratio than a petrol engine.
 - Thermal efficiency of a diesel engine is higher than a petrol engine.**
 - A diesel engine runs on Otto cycle
- When connected to the engine, the tachometer measures
 - Engine torque
 - Engine speed**
 - Engine compression
 - Engine temperature
- Reynolds number is

- a. $\frac{\text{inertia force}}{\text{thermal diffusivity}}$
 b. $\frac{\text{Static pressure orces}}{\text{thermal diffusivity}}$
 c. $\frac{\text{inertia force}}{\text{viscous force}}$
 d. $\frac{\text{Static Pressue force}}{\text{viscous force}}$
5. Which quantity is not listed in a typical psychometric chart?
- Entropy**
 - Enthalpy
 - Relative humidity
 - Wet-bulb temperature
6. The power required to drive a centrifugal pump is
- $\frac{wH_m}{Q\eta_o}$
 - $\frac{wH_m Q}{\eta_o}$
 - $\frac{wQ}{H_m\eta_o}$
 - $\frac{wQH_m}{H_m}$
- H_m = manometric head
 w = Specific weight
 Q = Discharge rate of pump
 η_o = overall efficiency of pump
7. In a refrigeration system the expansion device is connected between the
- Compressor and condenser
 - Condenser and evaporator**
 - Compression and evaporator
 - None of the above
8. The number of working strokes per minute for a four stroke cycle engine are _____ the speed of the engine in rpm.
- Equal to
 - One-half**
 - Twice
 - Four times
9. Which of the following pumps is generally used to highly viscous fluid?
- Centrifugal pump
 - Reciprocating pump
 - Diaphragm pump
 - Screw pump**
10. The primary function of economizers in boiler is to
- Increase the temperature of the standard steam without raising its pressure
 - Recover heat from the boiler flue gas to heat air for combustion
 - Heat feed water by utilizing heat from flue gases**
 - All of the above
11. Octane number of iso-octane is
- 0
 - 50

- c. **100**
 - d. 128
12. The desirable property of a refrigerant is
- a. **Low boiling point**
 - b. Low critical temperature
 - c. Low latent heat of vaporization
 - d. Low COP
13. The design of a thin walled pressure vessel is based on
- a. Longitudinal stress
 - b. **Hoop stress**
 - c. Both a & b
 - d. Radial stress
14. Which fuel has the highest heating value in weight basis?
- a. Kerosene
 - b. Natural gas
 - c. Diesel
 - d. **Gasoline**
15. The difference between higher heating value and lower heating value is
- a. Heat lost to atmosphere
 - b. **Latent heat of steam produced in combustion**
 - c. Difference of heat between solid and liquid fuel
 - d. Heat absorbed by cooling water of calorimeter
16. A helical coil spring of stiffness K is cut into two halves, the stiffness of the cut spring will be
- a. Same
 - b. Half
 - c. **Double**
 - d. One fourth
17. Rotameter is used to measure
- a. Viscosity
 - b. Specific gravity
 - c. Rotation or vortex
 - d. **Flow rate**
18. Brake power of an IC engine is
- a. **Power available at the flywheel**
 - b. Power actually developed by the engine
 - c. Frictional power overcome by the engine
 - d. Energy supplied by the fuel
19. Which is not a function of lubricants
- a. **Prevent knocking**
 - b. reduce friction
 - c. carry away contaminants

- d. seal for gases
- 20. The Kaplan turbine is a
 - a. Impulse – reaction turbine
 - b. Impulse turbine
 - c. **Reaction turbine**
 - d. None of the above

Power Grid Company of Bangladesh (PGCB)-2015

1. Write some names of gears. Mention the applications of worm gear.

Answer: Name of gears: 1.Spur gear, 2.Worm gear, 3.Bevel gear, 4.Helical gear etc.

Applications of worm gear: Worm gearing finds wide application in material handling and transportation machinery, machine tools, automobiles etc.

2. What is ton of refrigeration? Convert 1KW into ton.

Ton of refrigeration: A ton of refrigeration is defined as the amount of refrigeration effect produced by the uniform melting of one ton (1000 kg) of ice formed and at 0 degree Celsius in 24 hours.

Since the latent heat of ice is 335 kJ/kg therefore, one ton of refrigeration

$$1 \text{ TR} = 1000 \times 335 \text{ KJ in 24 hours}$$

$$= (1000 \times 335) / (24 \times 60) = 232.6 \text{ KJ/ min}$$

$$= 232.6 / 60 = 3.87 \text{ KW.}$$

In actual practice one ton of refrigeration is taken as equivalent to 210 KJ/min or 3.5 KW

3. Write the name of 5 systems of an engine.

Answer:

- 1. Air intake systems
- 2. Exhaust systems
- 3. Cooling systems
- 4. Lubrication systems
- 5. Fuel systems

4. Difference between evaporation and boiling. In which surface it works?

Answer: Difference between Boiling and evaporation:

- 1. A process in which a substance changes its state from the liquid state to the gaseous state is called boiling and a process in which a substance changes its state from the liquid state to the gaseous state without boiling is called evaporation.
- 2. Evaporation may occur when the partial pressure of vapor of a substance is less than the equilibrium vapor pressure. Boiling is a phase transition from the liquid phase to gaseous phase that occurs at or above the boiling temperature.
- 3. Boiling occurs throughout the liquid whereas; evaporation takes place only from the exposed surface of the liquid.
- 4. In boiling bubbles are formed but no bubbles are formed in evaporation.
- 5. Boiling is a rapid process while Evaporation is a slow process.
- 6. Boiling requires an external source of heat while evaporation can occur using the internal energy of the system.

5. What is air conditioner? Write difference between air conditioner and cooler.

Answer: An air conditioner is system designed to change the air temperature and humidity within an area. It can either be cold or hot.

Difference between air conditioner and cooler:

- a) An air conditioner is a system designed to change the air temperature and humidity within an area. It can either be cold or hot whereas a cooler cools the air by evaporating the air.
- b) In air conditioner warm air is run over refrigerant-filled coils, which absorbs heat and changes it from liquid to a gaseous state. The air is then converted back to liquid state and evacuated outside while in air cooler the air is pulled through the back of the unit and processed through wet absorptive pads and cooled.
- c) Air conditioner is less efficient compared to coolers.
- d) Conditioner is less environmental friendly.

6. Write the function of economizer and baffles.

Answer:

Function of Economizer: Economizer is a device used for heating feed water which is supplied to the boiler by utilizing heat in the exhaust flue gases before leaving through the chimney.

Function of Baffles: Baffles are used in Boilers to reduce turbulence in the flow of the hot combustion gases over the boiler tubes. The baffles maintain proper velocity of the gases which enables efficient energy transfer.

Baffles also guide the fly ash and slag to the proper place for deposition from where they can be easily removed.

If the Baffles are damaged, it will result in overheating at certain places and poor heating in others.

7. Write the applications of gas turbine. What are the advantages with respect to engine and steam turbine?**Applications of gas turbine:**

1. Gas turbine plants are used as standby plants for the hydro-electric power plants.
2. Gas turbine power plants may be used as peak loads plant and standby plants for smaller power units.
3. Gas turbines are used in jet aircrafts and ships. Pulverized fuel fired plants are used in locomotive.

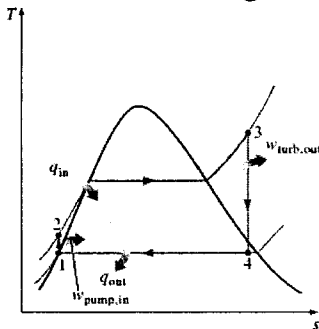
Advantages:

1. It is smaller in size and weight as compared to an equivalent steam power plant. For smaller capacities the size of gas turbine power plant is appreciably greater than a high speed diesel engine plant but for larger capacities it is smaller in size than a comparable diesel engine plant. If size and weight are the main consideration such as in ships, aircraft engines and locomotives, gas turbines are more suitable.
2. The initial cost and operating cost of the plant is lower than an equivalent steam power plant.
3. The plant requires less water as compared to a condensing steam power plant.
4. The plant can be started quickly, and can be put on load in a very short time.

5. There are no standby losses in the gas turbine power plant whereas in steam power plant these losses occur because boiler is kept in operation even when the turbine is not supplying any load.
6. The maintenance of the plant is easier and maintenance cost is low.

8. Draw the Rankine cycle and mention the function in every stage.

Answer: The T-S Diagram of Rankine cycle is shown below:



- 1-2 isentropic compression in a pump
- 2-3 Constant pressure heat addition in a boiler
- 3-4 isentropic expansion in a turbine
- 4-1 Constant pressure heat rejection in a condenser

9. A centrifugal pump having capacity 0.02 cusec can lift water at height of 100ft. if the efficiency is 62%. Find HP. (Similar)

Solution: Here, $Q = 0.02 \text{ cusec} = 0.02 \text{ ft}^3/\text{Sec} = 0.02 \times 0.0283 \text{ m}^3/\text{sec}$
 $= 5.66 \times 10^{-4} \text{ m}^3/\text{sec}$; $H = 100\text{ft} = 30.48\text{m}$, $\eta = 0.62$

$$\text{We know, Power, } P = \frac{\omega QH}{\eta} = \frac{9.81 \times 1000 \times 5.66 \times 10^{-4} \times 30.48}{0.62}$$

$$= 272.966 \text{ W}$$

$$= \frac{272.966}{746} = 0.36 \text{ HP (Answer)}$$

10. The wall thickness of a 4-ft-diameter spherical tank is 5/6 inch. Calculate the allowable internal pressure if the stress is limited to 8000 psi. (Similar)

Solution: We get,

$$\sigma = \frac{PD}{4t}$$

$$\Rightarrow 8000 = \frac{P \times 4 \times 12}{4 \times \frac{5}{6}}$$

$$\therefore P = 555.6 \text{ psi (Answer)}$$

11. Drawing

West Zone Power Distribution Company Ltd. (WZPDCL)-2016**Venue- MIST, Departmental- 70. GK 30.****1. Write the of Kelvin-Planck and Clausius statements of second law of thermodynamic.****Answer:****According to Kelvin-Planck-** "It is impossible to construct an engine working in a cyclic process whose sole purpose is to convert heat energy into an equivalent amount of work.**Clausius Statement:** It is impossible for a self-acting machine working in a cyclic process to transfer heat from a body at a lower temperature to a body at a higher temperature without the aid of an external agency.**2. Write notes on -a) Reversible process., b) Irreversible process, c) Adiabatic system d) Entropy****Answer: a) Reversible process:** A reversible process (also sometimes known as quasi-static process) is one which can be stopped at any stage and reversed so that the system and surroundings are exactly restored to their initial states.

This process has the following characteristics:

1. It must pass through the same states on the reversed path as were initially visited on the forward path.
2. This process when undone will leave no history of events in the surroundings.
3. It must pass through a continuous series of equilibrium states.

No real process is truly reversible but some processes may approach reversibility, to close approximation.

b) Irreversible process: Irreversible processes are the processes in which the system and its surroundings cannot be simultaneously returned to their initial states after the process has been completed.**Examples.**

- (a) Relative motion with friction (ii) Combustion (iii) Diffusion (iv) Free expansion (v) Throttling (vi) Electricity flow through a resistance (vii) Heat transfer (viii) Plastic deformation.

c) Adiabatic system: An adiabatic process is one that occurs without transfer of heat or matter between a thermodynamic system and its surroundings. In an adiabatic process, energy is transferred only as work. Such a process can be reversible or irreversible.**d) Entropy:** The measure of the level of disorder in a closed but changing system, a system in which energy can only be transferred in one direction from an ordered state to a disordered state. Higher the entropy, higher the disordered state. Higher the entropy, higher the disordered lower the availability of the system's energy to do useful work. i.e.

$$ds = \frac{dQ}{T} \text{ Where, } ds = \text{change of entropy.}$$

3. What is the difference between fire tube and water tube boiler?**Answer:**

Water Tube Boiler	Fire Tube Boiler
a) The water circulates inside the tubes which are surrounded by hot gases from the furnace.	a) The hot gases from the furnace pass through the tubes which are surrounded by water.

<ul style="list-style-type: none"> b) It generates steam at a highest pressure upto 165bar. c) The rate of generation of steam is high i.e. upto 450 tonnes per hour. d) For a given power, the floor area required for the generation steam is less, i.e. about 5 m² per tonne per hour of steam generation. e) Overall efficiency will economizer is upto 90%. f) It can be transported and erected easily as its various parts can be separated. g) It is preferred for widely fluctuating loads. h) The direction of water circulation is well defined. i) The operating cost is very high. j) The bursting changes are more. k) The bursting does not produce any destruction to the whole boiler. l) It is used for large power plants. 	<ul style="list-style-type: none"> b) It can generate steam only upto 24.5 bar. c) The rate of generation of steam is high i.e. upto 9 tonnes per hour. d) For a given power, the floor area required for the generation steam is less, i.e. about 8 m² per tonne per hour of steam generation. e) Overall efficiency will economizer is upto 75%. f) The transportation and erection is difficult. g) It can also cope reasonably with sudden increase in load but for a shorter period. h) The water does not circulate in a definite direction. i) The operating cost is less. j) The bursting changes are less. k) The bursting produces greater risk to the damage of the property. l) It is not suitable for large power plants.
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4. **What are CFC, HCFC and HFC? Give example of them with the effect on environmental pollution.**

Answer:

CFC (chlorofluorocarbons): They are molecules composed of carbon, chlorine and fluorine. They are stable, allowing them to reach the stratosphere without too many problems. At this stage, by transforming it contributes to the destruction of the ozone layer.

HCFC (hydro chlorofluorocarbon): They are molecules composed of carbon, chlorine, fluorine and hydrogen. They are less stable than CFCs destroy ozone and to a lesser extent. These are called transitional substances.

HFC (hydro fluorocarbons): They are molecules composed of carbon, fluorine and hydrogen. They do not contain chlorine and therefore do not participate in the destruction of the ozone layer. This is known as substitution substance. Restrictions on this family of gas are currently limited.

5. **Write the difference between pump, compressor, blower and fan.**

Answer:

Pump: A device which converts mechanical energy from a shaft into hydraulic (pressure) energy of a liquid. A pump is a device used to move fluids, such as liquids or slurries. A pump displaces a volume by physical or mechanical action. Pumps fall into two major groups: positive displacement pumps and roto dynamic pumps. For example, reciprocating pumps and gear pumps are positive displacement pumps whereas centrifugal pumps and submersible pumps are roto dynamic pumps.

Fan: A fan is a gas pump with relatively low pressure rise and high flow rate. Examples: window fans, ceiling fans, fans in computers and other electronics equipment, radiator fans in cars, etc.

Pressure Ratio (the ratio of the discharge pressure over the suction pressure): upto 1.11.

Blowers: A blower is a gas pump with relatively moderate to high pressure rise and moderate to high flow rate.

Examples: leaf blowers, hair dryers, air blowers in furnaces and automobile ventilation systems.

Pressure ratio: 1.11 to 1.20.

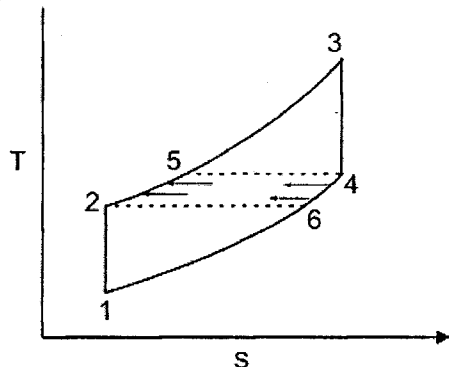
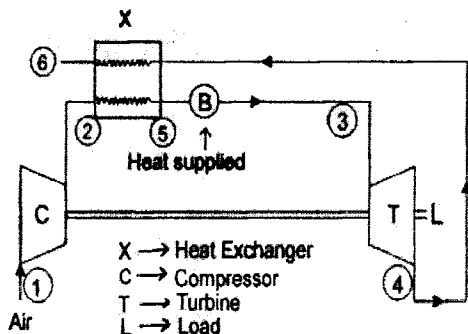
Compressor: A compressor is a gas pump designed to deliver a very high pressure rise, typically at low to moderate flow rates.

Examples: tire pumps, refrigerator and air conditioner compressors.

Pressure Ratio: Above 1.20.

6. Draw the schematic diagram and T-S diagram of regenerative gas turbine power plant cycle.

Answer: A regenerative cycle is illustrated in Figure below:



7. What is critical speed and whirling speed?

Answer: In Solid mechanics, in the field of rotor dynamics, the critical speed is the theoretical angular velocity which excites the natural frequency of a rotating object, such as a shaft, propeller or gear. As the speed of rotation approaches the objects natural frequency, the object begins to resonate which dramatically increases system vibration. The resulting resonance occurs regardless of orientation.

Whirling Speed is due to the unbalanced forces acting on a rotating shaft.

8. Why superchargers and turbochargers is used in engine?

Answer: Supercharger/Turbocharger: It is a device that helps in compression of additional air required for the efficient combustion of the fuel air mixture. The advantage of compressing the air is that it lets the engine stuff more air into a cylinder. At high speed and at high altitude there is a shortage of the intake air. At such times there is incomplete combustion which may lead to the loss of power. To avoid this loss, a device is installed in an automobile which increases the compression of air thus ensuring sufficient supply of air.

Difference between a supercharger and turbocharger:

The key difference between a supercharger and a turbocharger is the source of power for their operation. A supercharger consumes that is generated from the engine of the vehicle. It runs through a belt that is connected to engine shaft. Thus it is less efficient.

On the other hand, Turbocharger operates on the exhaust gas energy that would otherwise go waste. Thus it is an efficient device as compared to supercharger. However, there is an uncertainty involved with the turbocharger. For example the exhaust gas energy varies with speed and thus there is a certain lag when turbocharger is in operation. A supercharger has constant supply of energy and thus lag is negligible. But a supercharger is constant supply of energy and thus lag is negligible.

13. What is heat treatment? Why it is done?

Answer: Heat treatment: The process of heat treatment is carried out first by heating the metal and then cooling it in the caustic soda solution, brine, water, oil or air.

The purpose of heat treatment is to soften the metal, to change the grain size, to modify the structure of the material and to relieve the stresses set up in the material after hot or cold working.

14. A base load power plant has the capacity of 18000KW and a standby power plant has the capacity of 20000KW and Peak load of peak load unit 12000kW. The standby power plant runs 2910Hrs per year where the base load is year round. Peak load of Standby station unit is 12000kW. The annual generation of base load power plant is 101,350,000KWh and of standby power plant is 77,350,000KWh. Find the load factor, plant capacity factor and the use factor of these two power plants.

Solution:

Standby Power Plant

Capacity of Plant, $C=20000$ kW

Energy generated per year, $E=77,350,000$ kWh

Hours of working per year, $t=2910$ hrs

Hours in year, $T=8760$

Maximum demand, $M=12000$ kW

$$a) \text{ Annual load factor} = \frac{E}{M \times T} = \frac{77,350,000}{12000 \times 8760} = 0.736 = 73.6\%$$

$$b) \text{ Plant use factor} = \frac{M}{C \times t} = \frac{12000}{20000 \times 8760} = 0.44 = 44\%$$

$$c) \text{ Capacity factor} = \frac{E}{C \times t} = \frac{77,350,000}{20000 \times 2910} = 1.33 = 133\%$$

Base Load Power Plant

Capacity of Plant, $C=18000$ kW

Energy generated per year, $E=101,350,000$ kWh

Maximum demand, $M=12000$ MW

$$a) \text{ Annual load factor} = \frac{E}{M \times T} = \frac{101,350,000}{12000 \times 8760} = 0.964$$

$$b) \text{ Plant use factor} = \frac{M}{C} = \frac{101,350,000}{18000 \times 8760} = 0.64 = 64.3\%$$

$$c) \text{ Capacity factor} = \frac{E}{C \times t} = \frac{101,350,000}{18000 \times 8760} = 0.643 = 64.3\%$$

Some General Question WZPDCL**Translate into English (1 to 5)**

1. সকাল থেকে গুঁড়ি গুঁড়ি বৃষ্টি হচ্ছে।

Ans: It has been drizzling since morning

2. মেয়েটি যেমন বুদ্ধিমতি তেমন সুন্দরী।

Ans: The girl is as intelligent as brilliant.

3. আমি মরব তবু মিথ্যা বলব না।

Ans: I will die rather than tell a lie.

4. আয় বুঝে ব্যয় কর।

Ans: Cut your coat according to your clothes

5. আমার যদি পাখির মত ডানা থাকতো।

Ans: If I had the wings like a bird.

6. কেন্দ্রীয় শহীদ মিনারের স্থপতি কে?

Ans: হামিদুর রহমান

7. Who is the Writer of a long walk to freedom.

Ans: Nelson Mandela

8. In which year International Mother Language Day was announced?

Ans: November 17, 1999.

9. Full meaning:

1. LED: Light-Emitting Diode

2. CFL: Compact Fluorescent Lamp

10. Who is the Present UN representator of Bangladesh?

Ans: Masud Bin Momen

11. পৃথিবীর নিকটতম গ্রহ কোনটি?

Ans: শুক্র

12. প্রথম মহিলা মহাকাশচারীর নাম কি?

Ans: ভালেস্তিনা তেসেকোভা

13. In which year Bangladesh achieved test status?

Ans: 2000

14. সুয়েজ খাল কোন দুই মহাসাগরকে এক করে?

Ans: Mediterranean Sea and Red Sea

15. who is the current president of FIFA?

Ans: Gianni Infantino

Dhaka Electric Supply Company Limited (DESCO)**Post: AE (Electrical/Mechanical)****Time-10.00AM to 11.30AM****Date: 27.05.2016****Exam Hall: ECE,CE,EME Building, BUET**

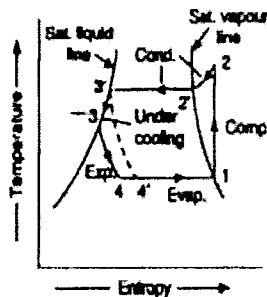
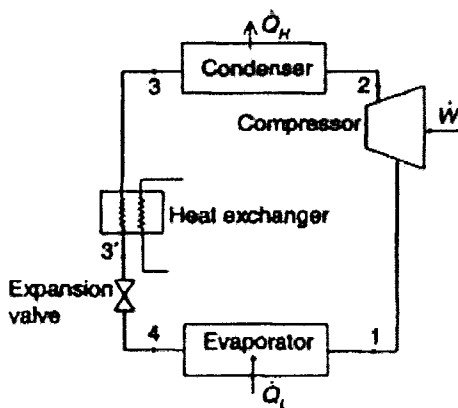
1. A refrigerator can introduce 3000Kg of ice 0°C from water at 30°C in 6 hours.
Determine the tonnage capacity of the refrigeration in TOR and KW.

Solution:Given, $m = 3000\text{Kg}$; $t = 6 \times 60 \text{ mins}$; $\Delta\theta = 30\text{K}$

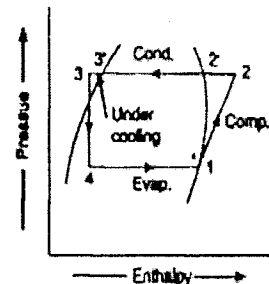
We get,

$$\begin{aligned}\therefore \text{Capacity} &= \frac{m l_f}{6 \times 60} + \frac{m s \Delta\theta}{6 \times 60} \\ &= \frac{3000 \times 335}{6 \times 60} + \frac{3000 \times 4.2 \times 30}{6 \times 60} \\ &= 3841.65 \text{ KJ/min} \\ &= 18.27 \text{ TOR (Answer)} \\ &= 64 \text{ KW (Answer)}\end{aligned}$$

2. Draw the block diagram of a vapor compression refrigeration system and shown the cycle in p-h and T-S plane with sub-cooling.

Answer:

(a) T-s diagram.



(b) p-h diagram.

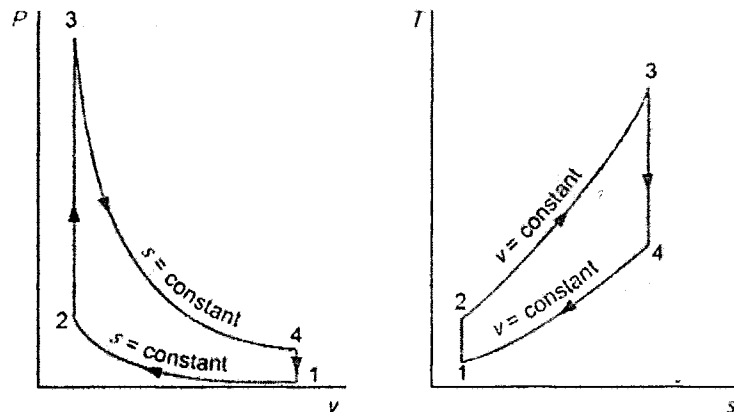
3. A pressure gauge attached to a rigid tank reads a vacuum of 60KPa. If the atmospheric pressure is 12m of water column, find the absolute pressure of air inside the tank in KPa.

Solution: Given, Vacuum Pressure = 60KPa;Atmospheric Pressure = 12m of water = $12 \times 9.81 = 117.72 \text{ KPa}$ \therefore Absolute pressure = Atmospheric Pressure - Vacuum Pressure

$$= (117.72 - 60) \text{ KPa} = 57.72 \text{ KPa (Answer)}$$

4. Draw the P-V and T-S diagram and the name of the different processes involved in a four stroke petrol engine.

Answer:



Where,

1-2: Adiabatic compression

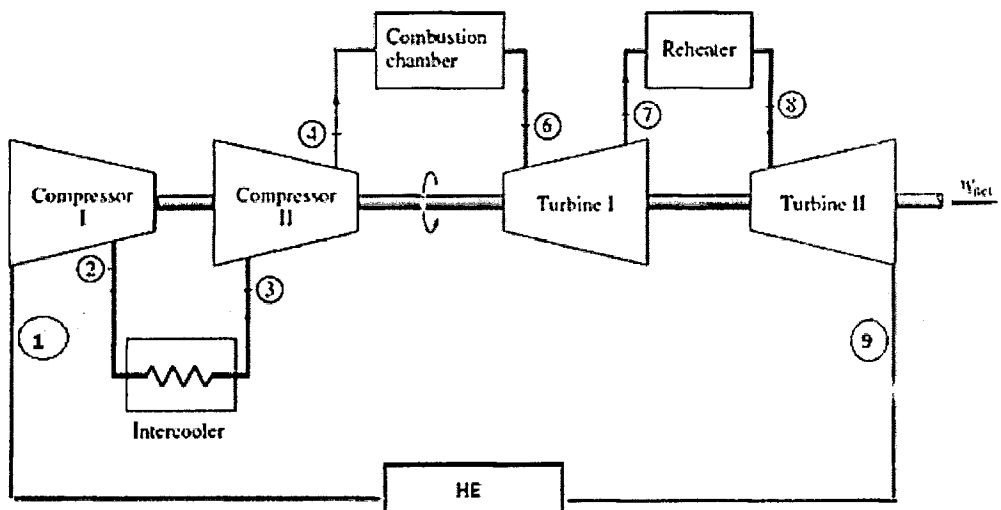
2-3: Isochoric heat addition

3-4: Adiabatic expansion

4-1: Isochoric heat rejection

5. Draw the schematic diagram for the Brayton cycle (two stage compression) in a gas turbine with inter-cooling and reheating.

Answer:



6. A diesel engine has a compression ratio of 20 and cut-off takes place at 5% of the stroke. Find the air standard efficiency. Assume $\gamma = 1.4$.

Solution: Given, $r = \frac{V_4}{V_1} = 20$; $\gamma = 1.4$;

Volume at cut off = $V_2 = V_1 + 0.05(V_4 - V_1)$

Let, $V_1 = 1$; $V_4 = 20$

\therefore Volume at cut off = $V_2 = V_1 + 0.05(V_4 - V_1)$

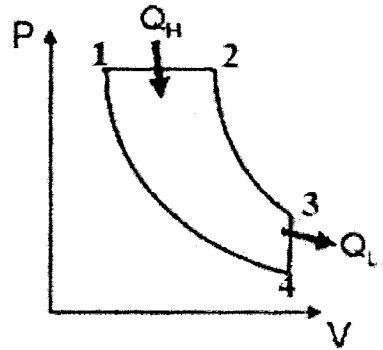
$$= 1 + 0.05(20 - 1) = 1.95$$

$$\therefore \text{Cut off ratio} = \frac{V_2}{V_1} = 1.96$$

$$\therefore \eta = 1 - \frac{1}{r^{\gamma-1}} \left[\frac{\rho^{\gamma-1}}{\gamma(\rho-1)} \right]$$

$$= 1 - \frac{1}{20^{1.4-1}} \left[\frac{1.96^{1.4} - 1}{1.4(1.96 - 1)} \right]$$

$$= 0.6485 \text{ or } 64.85\% \text{ (Answer)}$$



7. Heat is transferred from $2\text{m} \times 3\text{m}$ steel plate due to the flowing of air with heat transfer co-efficient of $5.5 \text{ W/m}^2 \text{ } ^\circ\text{C}$. The temperature of the path is 80°C and that of the flowing air is 25°C . Calculate the amount of heat transfer.

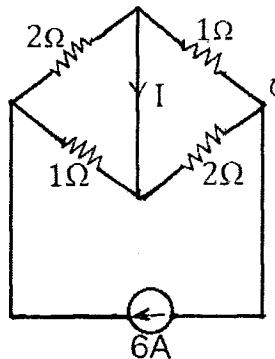
Solution: Given, Area, $A = 6 \text{ m}^2$; $h = 5.5 \text{ W/m}^2 \text{ } ^\circ\text{C}$, $\Delta T = 80 - 25 = 55 \text{ } ^\circ\text{C}$

We get, The amount of heat transfer = $hA \Delta T$

$$= 5.5 \times 6 \times 55$$

$$= 1815 \text{ W (Answer)}$$

8. Find out the value of 'I':



Solution:

We get from Loop 3: $I_3 = 6\text{A}$

From Loop 1: $I_1 \times (2 + 1) - I_3 \times 1 = 0$

$$\Rightarrow 3I_1 - 6 = 0$$

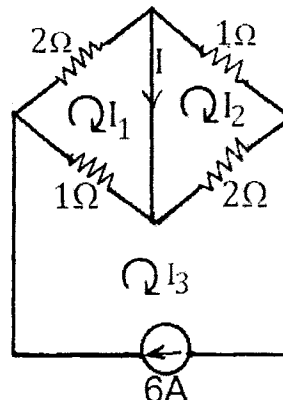
$$\therefore I_1 = 2 \text{ A}$$

From Loop 2: $I_2 \times (2 + 1) - I_3 \times 2 = 0$

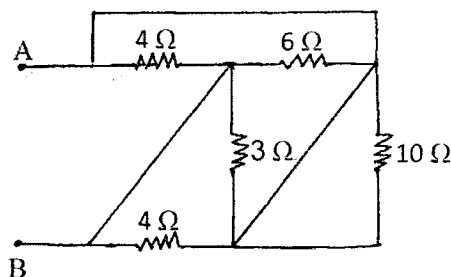
$$\Rightarrow 3I_2 - 2 \times 6 = 0$$

$$\therefore I_2 = 4 \text{ A}$$

$$\therefore I = I_1 - I_2 = 2 - 4 = -2 \text{ A (Answer)}$$



9. Find equivalent resistance between A-B in the following circuit:



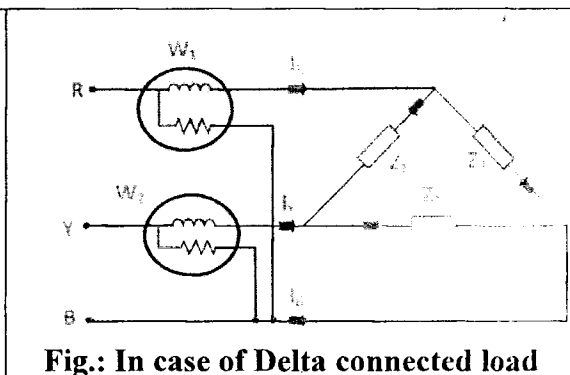
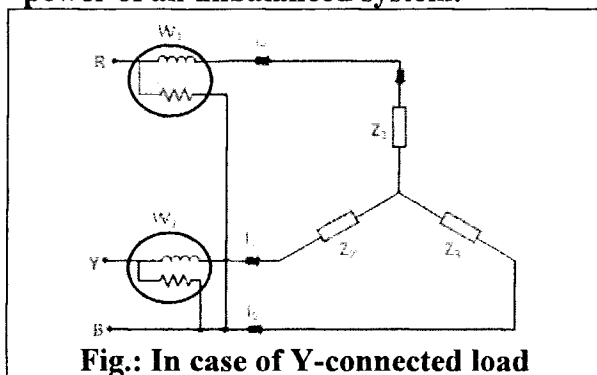
Solution:

$$\frac{1}{R_{AB}} = \frac{1}{4} + \frac{1}{3} + \frac{1}{4} + \frac{1}{6} = \frac{3+4+3+2}{12} = 1$$

$\therefore R_{AB} = 1 \Omega$ (Answer)

10. A 3 phase, 5hp, 220V Y-connected motor has an efficiency of 85%. Determine power factor when it draws 15A current from line.

11. Draw the connection diagram for two wattmeter method of measuring 3 Phase power of an unbalanced system.

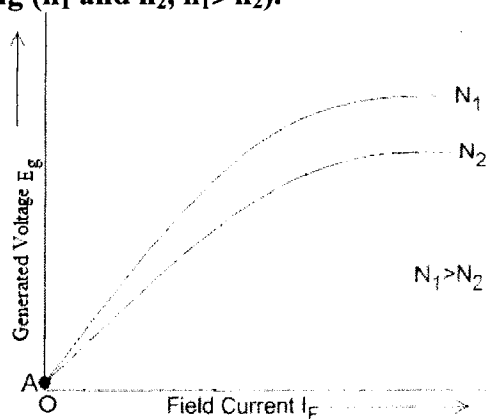


12. Write down the names of the methods of speed control for DC shunt motors.

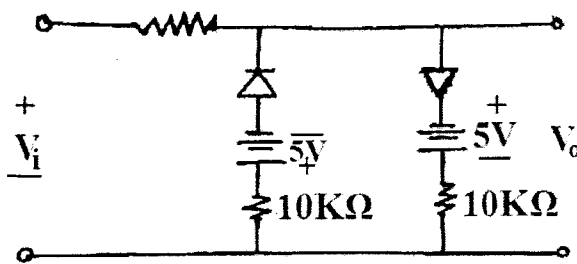
The speed of a shunt motor can be changed by

- (i) Flux control method
- (ii) Armature control method
- (iii) Voltage control method

13. Draw typical open circuit characteristic (OCC) curves of a DC shunt generators at two different rpm setting (n_1 and n_2 , $n_1 > n_2$).



14. Assuming the diodes to be ideal, draw the output voltage (V_0) wave from for the circuit shown below. The input voltage (V_1) is sinusoidal with a magnitude of 20 (peak to peak) and a frequency of 100Hz.



Non-Departmental

- Prime minister of which country resigned due to panama papers scandal?
Ans: Iceland's Prime Minister Sigmundur David Gunnlaugsson
- Secretary General of commonwealth nations?
Ans: Patricia Scotland, Baroness Scotland of Asthal
- Victoria Fall's base river - in southern Africa on the Zambezi River at the border of Zambia and Zimbabwe.
- G-7 countries
Ans: Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.
- Duralumin is an alloy of copper and ?
Ans: Aluminium
- War of roses
Ans: The Wars of the Roses were a series of dynastic wars for the throne of England.
- Tunnel between France and Italy
Ans: Mont Blanc Longest Tunnel in World (Road)
- Land of thousands lakes
Ans: Finland
- Where will UEFA Euro 2016 be held ?
Ans: France from 10 June to 10 July 2016.
- Brexit means-

Ans: Before the end of 2017, British voters will decide whether their country will remain a part of the European Union. Brexit is an abbreviation of "British exit" that mirrors the term Grexit. It refers to the possibility that Britain will withdraw from the European Union. The country will hold an in-out referendum on its EU membership on June 23.

11. jeevan rekha life line express is

Ans: World's first hospital train Prime minister of which country resigned over

12. Who is the Secretary General of commonwealth?

Answer: Patricia Scotland

Bangla

১৩. দর্শন এর প্রকৃতি প্রত্যয় কি? - দৃশ+অনট

১৪. আকাশ এর প্রতিশব্দ- নীলাম্বু

১৫. বৈকুণ্ঠের উইল কার লেখা? শরৎচন্দ্র চট্টোপাধ্যায় ।

১৬. আরণ্যক কার লেখা? বিভূতিভূষণ চট্টোপাধ্যায় ।

১৭. যে নারীর হাসি সুন্দর? গুচিখিতা

১৮. কোন বানানটি শুদ্ধ? - মুমূর্ষু

১৯. খন্ড প্রলয়- ভীষণ ব্যাপার

২০. যতি চিহ্ন কয়টি = ১১ টি

২১. কমা এর চেয়ে বেশি বিরতির জন্য কোন যতি চিহ্ন ব্যবহার হয়-সেমিকোলন

২২. সুলতানার স্বপ্ন বেগম রোকেয়া সাখাওয়াত হোসেন

23. Antonym: Meticulous -- undemanding

14. Antonym: Pious--impious

25. Antonym: Felicitation -- denunciation

26. Kemal Ataturk was-- the founder of modern Turkey

27. The tunnel that connects France and Italy is

A. St. Gothard road Tunnel

B. Mont Blanc Tunnel

C. Mersey (Queens's way) Tunnel

D. Orange Fish rivers Tunnel

[বাকিগুলো সংগ্রহ করা যায়নি।]

M.Sc. Admission Question, BUET.-2016

Full Marks- 100, Total Questions- 30

Time: 1hr 30 mins

1. Write the difference between stress intensity and fracture toughness.

Answer:

Stress Intensity:

The stress intensity factor, K, is used in fracture mechanics to predict the stress state ("stress intensity") near the tip of a crack caused by a remote load or residual stresses. It is a theoretical construct usually applied to a homogeneous, linear elastic material and is useful for providing a failure criterion for brittle materials, and is a critical technique in the discipline of damage tolerance.

Fracture Toughness:

In materials science, fracture toughness is a property which describes the ability of a material containing a crack to resist fracture, and is one of the most important properties of any material for many design applications.

2. Write two dimensional heat conduction equation and application.

Answer: The controlling differential equation for two dimensional steady state heat conduction is given by,

$$\frac{\delta^2 t}{\delta x^2} + \frac{\delta^2 t}{\delta y^2} + \frac{q}{K} = \frac{1}{\alpha} \frac{\delta T}{\delta t}$$

3. Difference between pump, fan, blower, compressor.

Answer:

Pump: Pumps increase the mechanical energy of the liquid, increasing its velocity, pressure, or elevation-or all three. Devices used to transport/move incompressible fluid through pipes & channels.

Example: Positive-Displacement Pumps (Piston, plunger, diaphragm, lobe, gear, screw etc.) Centrifugal Pumps.

Fan: A fan is a gas pump with relatively low pressure rise and high flow rate. Examples: window fans, ceiling fans, fans in computers and other electronics equipment, radiator fans in cars, etc.

Pressure Ratio (the ratio of the discharge pressure over the suction pressure): upto 1.11.

Blowers: A blower is a gas pump with relatively moderate to high pressure rise and moderate to high flow rate.

Examples: leaf blowers, hair dryers, air blowers in furnaces and automobile ventilation systems.

Pressure ratio: 1.11 to 1.20.

Compressor: A compressor is a gas pump designed to deliver a very high pressure rise, typically at low to moderate flow rates.

Examples: tire pumps, refrigerator and air conditioner compressors.

Pressure Ratio: Above 1.20.

4. Define Reynolds number. Write the of Reynolds number value for laminar and turbulent flow in flat surface and pipe

Reynolds Number: It is defined as the ratio of the inertia force to the viscous force. i.e.,

$$Re = \text{Inertia Force} / \text{Viscous Force} = \rho V D / \mu = V D / \nu$$

For flat plate- Values under 500,000 are classified as Laminar flow where values from 500,000 to 1,000,000 are deemed Turbulent flow.

For pipe flow if $Re < 2000$, the flow is laminar, if $Re > 4000$, the flow is turbulent.

If $2000 < Re < 4000$ it is transition.

5. Explain VVT, DI, Turbo charger.

Answer:

VVT (variable valve timing):

In internal combustion engines, variable valve timing (VVT) is the process of altering the timing of a valve lift event, and is often used to improve performance, fuel economy or emissions. It is increasingly being used in combination with variable valve lift systems. There are many ways in which this can be achieved, ranging from mechanical devices to

electro-hydraulic and camless systems. Increasingly strict emissions regulations are causing many automotive manufacturers to use VVT systems.

DI (Direct Injection):

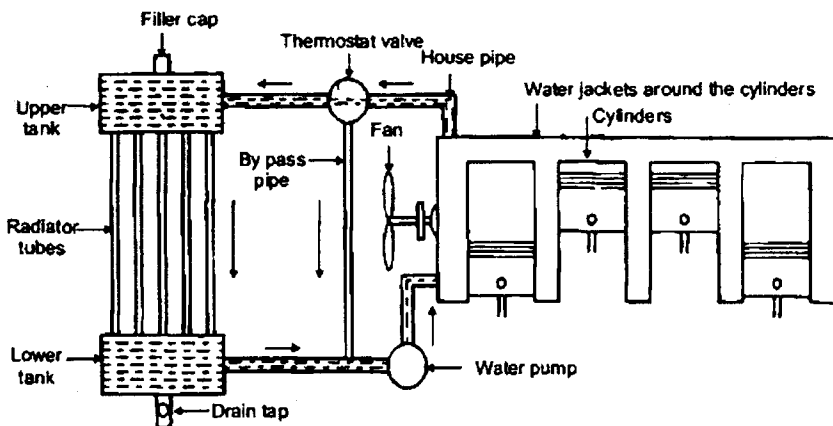
Gasoline direct-injection engines generate the air/fuel mixture in the combustion chamber. During the induction stroke, only the combustion air flows through the open intake valve. The fuel is injected directly into the combustion chamber by special fuel injectors instead of carburation.

Turbocharger:

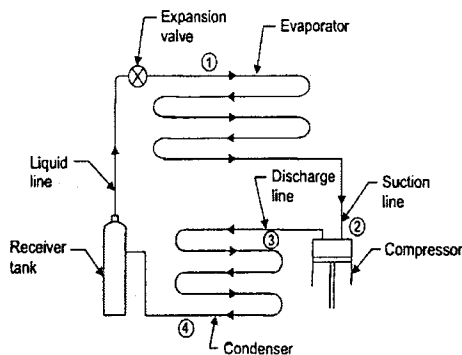
Turbocharger is a forced induction device used to allow more power to be produced for an engine of a given size. They compress air flowing into the engine. The advantage of compressing the air is that it lets the engine squeeze more air into a cylinder & more air means that more fuel can be added. Then more power gets from each explosion in each cylinder. A turbocharger produces more power overall than the same engine without the charging. It also employed in diesel engine.

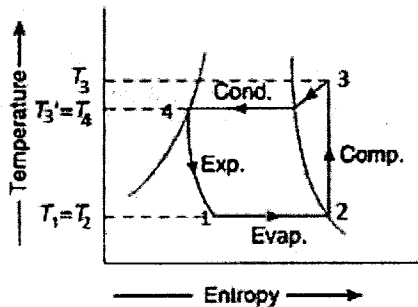
6. Draw cooling circuit diagram of a car.

Answer:

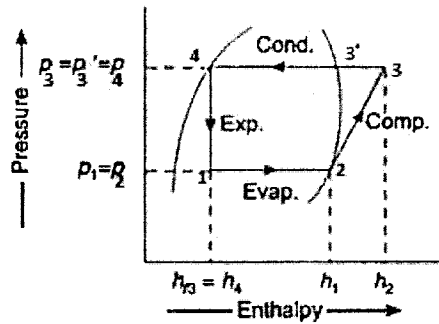


7. Draw the schematic and T-S diagram of vapor compression refrigeration system.





(a) T-s diagram.



(b) p-h diagram.

8. Name 3 fluid measuring meters. Which one has the best accuracy?

Orifice meter: It is a device used for measuring the rate of flow of fluid through a pipe. It is cheaper device a compared to venturimeter. It consists of a flat circular plate which has a circular sharp edged hole called orifice through it may vary from 0.4 to 0.8 times the pipe diameter

Venturimeter: A venturimeter is a device used for measuring the rate of flow of fluid flowing through a pipe. It is based on the principle of Bernoulli's equation. It consists of three parts:

- (a) A short converging part (b) Throat, and (c) Diverging part

Pitot tube: It is a device for measuring the velocity of flow at any point in a pipe or a channel. It is based on the principle that if the velocity of a flow at point becomes zero, the pressure there is increased due to the conversion of the kinetic energy. It consists of a glass tube bent at right angles.

- Among three of the above **Venturimeter** has the best accuracy.

9. What is deaeration? Why Is It done and where?

Answer: Deaeration is the removal of dissolved or entrained gases from water to be used as boiler feed or for other processes. The gases of concern to steam plant operators are usually oxygen and carbon dioxide which are present in water due to natural cases.

Why it is done:

Oxygen and carbon dioxide present in untreated water cause corrosion of the usual boiler and steam plant materials. The rate of the corrosive action is proportional to the amount of the gas present in the feedwater and is accelerated by high temperature.

There are five major problems directly associated with water quality that will effect boiler performance. These are Scale formation, Corrosion, Fouling, Foaming and Embrillement.

10. Write down the assumptions of Bernoulli's equation. Write down Bernoulli's equation for a horizontal stream line.

Answer: Assumptions: 1. the fluid is ideal, i.e. viscosity is zero. 2. The flow is in compressible and steady and Irrotational.

Bernoulli's Equation:
$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 + h_f$$

11. Write the T-S diagram of ideal reheat steam cycle.

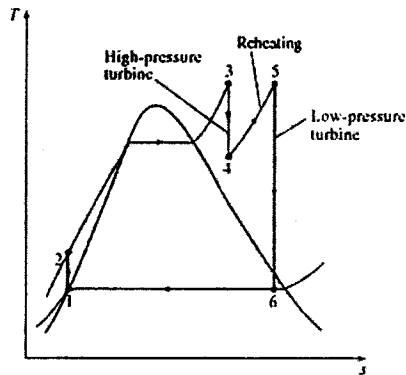


fig- re-heat cycle

12. Two plates are compressed and their joining surface is ribbed surface. Write down the equation of rate of heat transfer?
13. Write velocity profile of boundary layer of laminar and turbulent pipe flow and for flow over a plate.

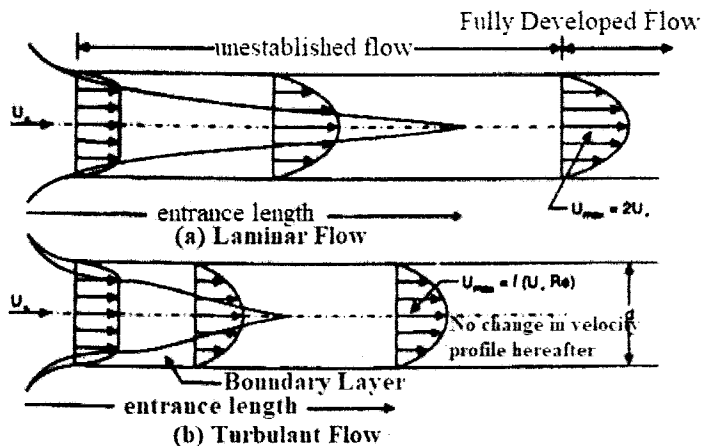


Fig.: Boundary layer for pipe flow

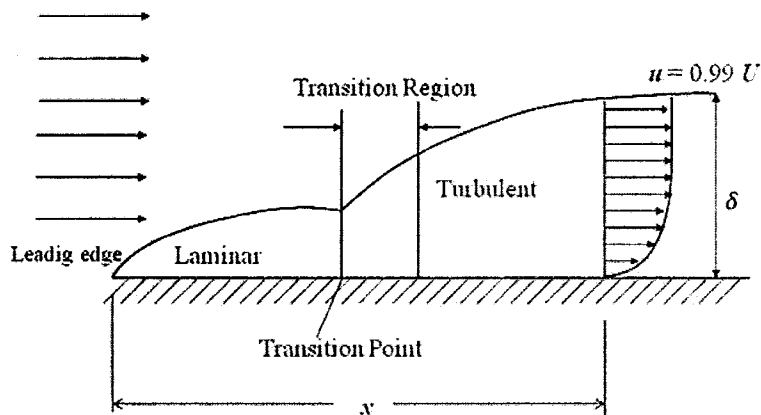
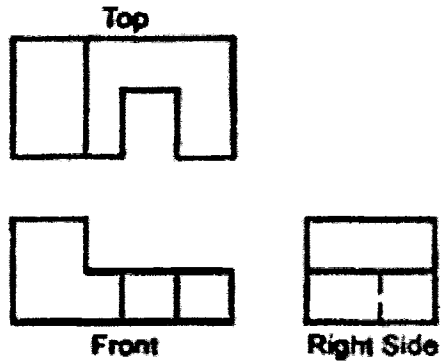
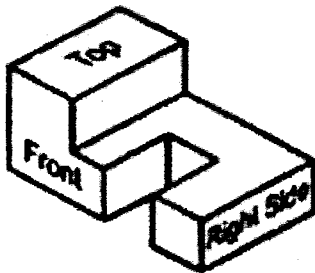


Fig.: Boundary layer for flat plate.

14. Draw TOP VIEW, FRONT VIEW and RIGHT Side, LEFT side VIEW.**Mathematical Problems:**

We cannot collect the mathematical data. So we are unable to provide any solution. Just related topics are given:

1. Power plant related math with varying load in 24hrs.
2. Spherical thin wall pressure vessel.
3. Helical gear pitch circle diameter and angle.
4. Counter flow heat exchanger LMTD related math.
5. Fluid mechanics math (Mach number related).
6. Pulley related math.
7. Fluid mechanics frictional head loss related math.
8. Gear train related math.
9. Draw SFD of a beam with point load

Gas Transmission Company Ltd.(GTCL)-2016**Post: Assistant Engineer(Mechanical)****Time-10.00AM to 11.30AM****Date:03.06.2016****Exam Hall: EME Building, BUET****[Technical Question Only]**

$$1 \times 10 = 10; 5 \times 12 = 60$$

1. For safety, control and operation which one is used?
 - a) **Boiler mountings**
 - b) Boiler accessories
 - c) Boiler mountings and accessories
 - d) All of the above
2. Emission of exhaust gas contains harmful elements-
 - a) CO, CO₂, HC, H₂O, Sox, NO_x and PM (Particulate Matter)
 - b) **CO, CO₂, HC, SO_x, NO_x and PM (Particulate Matter)**
 - c) CO, CO₂, HC, H₂O, NO_x and PM (Particulate Matter)
 - d) CO, CO₂, HC, H₂O, Sox, NO_x and PM (Particulate Matter)
3. Stoichiometric air fuel ratio means ratio of-
 - a) Mass of air to mass of fuel
 - b) Mass of fuel to mass of air
 - c) **Volume of air to volume of fuel**
 - d) Volume of fuel to volume of air
4. Which measures the flow rate of the closed channel?
 - a) Odameter
 - b) -----
 - c) **Orifice meter**
 - d) V-notch
5. Stress concentration occurs due to
 - a) Excessive stress
 - b) Uniformly distributed stress
 - c) **Non-uniformly distributed stress**
 - d) -----

Note: There is confusion with this question. In machine design book of khurmi says, stress concentration occurs due to – abrupt change of cross-section.

6. Rockwell test is used for the test of
 - a) **Hardness**
 - b) Ductility
 - c) ----- d)-----
7. Principal stress is defined as
 - a) Maximum shear stress
 - b) **maximum normal stress**
 - c) Maximum shear stress and maximum normal stress

8. Octane number increases means the-
- Increasing of knocking tendency
 - Increasing the possibility of auto ignition
 - Increasing the resistance to knocking**
9. Buckling load increases by _____ with the slenderness ratio.
- Increasing
 - Decreasing**
 - Both
10. What is the full meaning of EFI –
- Electronic Fuel Ignition
 - Electric Fuel Ignition
 - Electronic Fuel Injection**
 - Electrical Fuel Injection

11. By the definition of tonnage capacity calculate the amount of refrigeration tonnage in terms of KW. The latent heat of water to ice of 0 °C is 333.55 KJ/Kg.

Solution:

For (short) ton of refrigeration:

One short ton = 2000 lb

$$\begin{aligned}\text{By the definition we get, tonnage capacity} &= \frac{(2000 \times 0.4536) \times 333.55}{24 \times 3600} \\ &= \mathbf{3.50 \text{ KW (Answer)}}\end{aligned}$$

For Tonne of refrigeration:

$$\begin{aligned}\text{By the definition we get, tonnage capacity} &= \frac{1000 \times 333.55}{24 \times 3600} \\ &= \mathbf{3.86 \text{ KW (Answer)}}\end{aligned}$$

12. Write while the petrol engine or diesel engine is used in the following vehicles:

Name of the Vehicles	Petrol or Diesel Engine
Buses, Trucks	Answer: Diesel Engine
(Heavy Duty, High speed)	
Scooters, Motorcycles, Cars	Petrol Engine
(Light Duty, High speed)	
Aero plane, Aircraft	Petrol Engine
(High speed)	
Ships, Marine vehicles	Diesel Engine

13. A hydro-electric power plant works at a head of 200 m. If flow rate is 10 m³/s maintained through the turbine and the combined turbine-generator efficiency is 76.5%. What will the total electric power available from the plant?

Solution: Given, H = 200m; Q = 10 m³/s; $\eta = 0.765$;

$$\text{We get, } \eta = \frac{P}{\rho g H Q}$$

$$\begin{aligned}\therefore P &= \eta \rho g H Q \\ &= 0.765 \times 1000 \times 9.81 \times 200 \times 10 \text{ Watts} \\ &= \mathbf{15.0093 \text{ MW (Answer)}}\end{aligned}$$

14. Define Reynolds Number. What are the limiting value of the Reynold's for flow to be consider on 'laminar' or 'turbulent' in case of pipe flow and in case of flat plates.

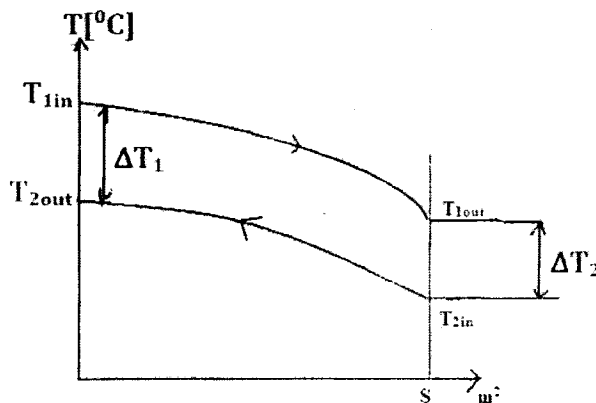
Answer: Reynolds Number: It is defined as the ratio of the inertia force to the viscous force. i.e., $Re = \text{Inertia Force} / \text{Viscous Force} = \rho V D / \mu = V D / \nu$

Reynolds number Range:

Flow Through	Laminar	Turbulent
Pipe	$Re < 2000$	$Re > 4000$
Flat Plate	$Re < 5 \times 10^5$	$5 \times 10^5 \leq Re \leq 10^7$

15. Water is heated from 35°C to 75°C by oil in a counter flow double pipe heat exchanger. The oil enters the heat exchanger at 111°C and leave at 75°C. Calculate LMTD in this situation.

Solution:



Here, $T_{cin} = 35^\circ\text{C}$ and $T_{cout} = 75^\circ\text{C}$, $T_{hin} = 111^\circ\text{C}$ and $T_{hout} = 75^\circ\text{C}$.

$$\Delta T_1 = T_{hin} - T_{cout} = 111 - 75 = 36 \text{ and } \Delta T_2 = T_{hout} - T_{cin} = 75 - 35 = 40$$

$$\begin{aligned} \therefore \text{LMTD} &= \frac{\Delta T_2 - \Delta T_1}{\ln \frac{\Delta T_2}{\Delta T_1}} \\ &= \frac{40 - 36}{\ln \frac{40}{36}} \end{aligned}$$

$$\therefore \text{LMTD} = 37.97 \approx 38^\circ\text{C} \text{ or } 38 \text{ K (Answer)}$$

16. A pump is to deliver 10 liters/sec of water at a pressure of 10 bar. If the combined efficiency of the drivers motor and the pump is 67%. Calculate the rating power of the driving motor.

Solution: Here, $Q = 10 \text{ Litres/sec} = 10 \times 10^{-3} \text{ m}^3/\text{s}$ $P = H \rho g = 10 \text{ bar} = 10 \times 10^5 \text{ N/m}^2$
 $\Rightarrow H = 101.94 \text{ m}$

$$\begin{aligned} \text{We get, } \eta &= \frac{\rho g H Q}{P} \\ &= \frac{10 \times 10^5 \times 10 \times 10^{-3}}{P} \end{aligned}$$

$$\therefore P = 14925.37 \text{ W or } 20 \text{ Hp (Answer)}$$

17. Estimate the shearing load at which a 25mm diameter steel bolt will be sheared off if the shear strength is 140 MPa.



Solution: We get, $\tau = \frac{V}{A}$

$$\Rightarrow V = \tau A$$

$$\Rightarrow V = 140 \times \frac{\pi}{4} D^2 = 140 \times \frac{\pi}{4} 0.025^2 = 68.72 \text{ kN (Answer)}$$

18. Find the power transmitted by a belt drive generating a torque 50N.m at 700 rpm.

Solution:

Here, $N=700\text{rpm}$; $\omega = \frac{2\pi N}{60} = \frac{2\pi \times 700}{60} = 73.30 \text{ rad/sec}$

We get, $P = T \times \omega = 50 \times 73.30 = 3665.19 \text{ Watts} = 3.67 \text{ KW (Answer)}$

19. Find out the bursting pressure of a steel pipe of 20mm wall thickness and 280 MPa tensile strength.

Solution: Given, $t = 20\text{mm} = 0.02\text{m}$; By the definition of thin wall pressure vessel,

$t = \frac{D}{15}$ or, $\frac{D}{20}$ or, $\frac{D}{10}$ Taking, $t = \frac{D}{15}$ We get, $D = 0.3\text{m}$

$$\begin{aligned} \sigma_t &= \frac{PD}{2t} \\ \therefore P &= \frac{2t\sigma_t}{D} \\ &= \frac{2 \times 0.02 \times 280}{0.3} \\ &= 37.33 \text{ MPa (Answer)} \end{aligned}$$

20. A bus starts from rest with a constant acceleration of 1m/s^2 . Determine the time required for it to attain a speed of 25 m/s and the distance travelled.

Solution: Given, $a=1\text{m/s}^2$, $V= 25 \text{ m/s}$

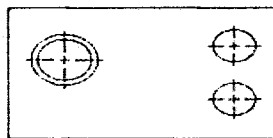
We get, $V= at$

$$\Rightarrow 25 = 1 \times t$$

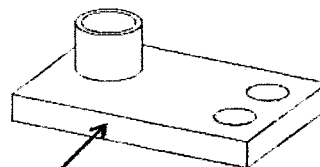
$$\Rightarrow t = 25 \text{ sec (Answer)}$$

Again, $S = \frac{1}{2}at^2 = 0.5 \times 1 \times 25^2 = 312.5\text{m (Answer)}$

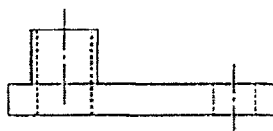
21. Draw the TOP view and FRONT view.



Top view

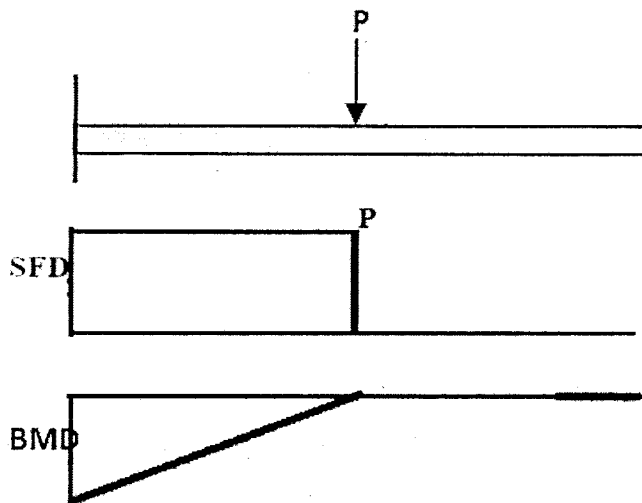


Front



Front view

22. Draw the shear force and bending moment diagram.



[Non-Departmental Questions Only] $0.5 \times 60 = 30$

- Which among the following is busiest ocean trade route?
a. Suez Canal b. **North Atlantic Route** c. Panama Canal d. South Atlantic Route
- Who is the highest wicket taker in T20 World cup? – **Mohammad Nabi**
- Kyat is the currency of- **Myanmar**
- Why do we use reboot system in a computer?- **because the installation of new software or hardware**
- Who was the finance minister in 1971?- **Mansur Ali**
- What is the scalar unit? a. force b. **pressure** c. velocity d. acceleration
- Vinegar contains the acid- acetic acid
- Epicenter is connected with – a) **Earthquake** b) Volcano c) cyclone
- Which pair is not correct? a) Kyrro – Nile b) New York – Hardson c) **Vicana- Volga**
- Dolomite is the ore of – a) **Mg** b) Fe c) Pb d) Tin
- Which element is most important for stainless stress? a) **Chromium** b) Carbon c) Tin d) Zn
- How to calculate the age of tree? – ring system
- Acid rain occurs caused by – a) CO and S b) **N₂O and S** c)
- The 69th film festival was held in – a) **Canne Franch** b) Zurich- Suizerland
- The study which deals with mountains – **Orology**

Synonyms

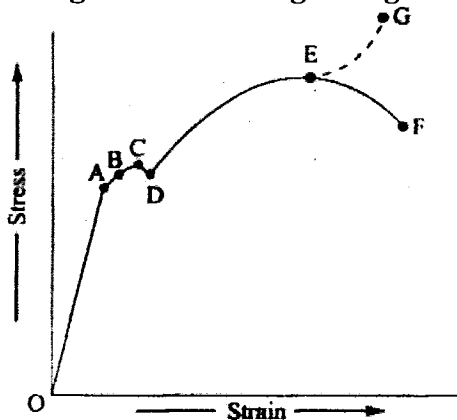
- Brilliant – Dazzling
- Handsome- Elegant
- Pious- Reverent
- Moderate- Unrestrained
- Perseverance- Tenacity
- Prepositions
- He reached Chittagong by train
- He is taller among of the two brothers
- The plane take off the airport
- The headmaster sent in student for Mathematics Olympic.

25. বাংলা ভাষার উৎস কোন ভাষা? ক) বৈদিক খ) অনার্য
26. ষষ্ঠ এর সন্ধি বিচ্ছেদ কোনটি? - ষষ+থ
27. প্রাতরাশ এর সন্ধি বিচ্ছেদ কোনটি? প্রাতঃ+আশ
28. সারাটি বিকেল তোমার আশায় বসে আছি। এখানে “সারাটি” কোন অর্থে ব্যবহৃত হয়েছে? নির্থকভাবে
29. সংস্কৃত এর লেখক- শহীদুল্লাহ কায়সার
30. বাংলায় যতি চিহ্ন কয়টি? - ১১টি
31. রূপতত্ত্বের এর অপর নাম কি? শব্দতত্ত্ব
32. বাক্যের মৌলিক একক কোনটি? শব্দ
33. সংশয় এর বিপরীত শব্দ কোনটি? ক. প্রত্যয় খ. বিন্ময় গ. নিঃসয় ঘ. নির্ভয়
34. কুঞ্জর এর প্রতিশব্দ কি? - হাতী
35. বুকের রক্ত দিয়ে লিখেছি একটি নাম বাংলাদেশ। এটি কোন কালের উদাহরণ? পুরাণটমান বর্তমান
36. সন্ধ্যায় সূর্য অস্ত যায়- নিত্যবস্তু বর্তমান।
37. কোনটি শুদ্ধ বানান? - A. নির্ণিমেষ B. শির্নিমেষ C. নির্নিমেষ D. নির্নিমেষ
38. খোদা কোন ভাষার শব্দ? - ফারসি
39. অর্ধ-তৎসম শব্দ কোনটি? ক) সূর্য খ) জোছনা
40. A company has its area in comilla , barisal or so on which types of network is used – A) LAN B) WAN
41. What is needed in human body for balancing of water? –
[বাকিগুলো সংগ্রহ করা সম্ভব হয়নি।]

Gas Transmission Company Ltd. (GTCL 2010)

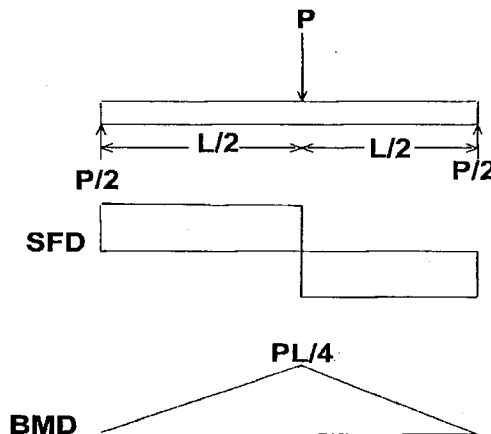
10×5 = 50

1. Draw the typical stress-strain diagram of mild steel showing yield strength, ultimate strength and breaking strength on it.



- A- Proportional limit
 B- Elastic limit
 C- Upper yield point
 D- lower yield point
 E- Ultimate stress/strength
 F- Breaking stress/strength
 G- Actual Rupture Strength

2. A concentrated load P is applied at the midspan of a simply supported beam of length L . Draw the shear force and bending moment diagrams of the beam showing peak values.



3. A steel rod of 1 cm^2 in cross-sectional area and 100 cm long is subjected to an axial pull of 2000 kgf. Find the elongation of the rod considering $E=200 \text{ GPa}$.

Solution: Here,

Area, $A = 1 \times 10^{-4} \text{ m}^2$; $L = 0.1 \text{ m}$; $P = 2000 \text{ Kg} = 2000 \times 9.81 = 19620 \text{ N}$; $E = 200 \times 10^9 \text{ Pa}$

We know, $\delta = \frac{PL}{AE} = \frac{19620 \times 0.1}{1 \times 10^{-4} \times 200 \times 10^9} = 9.81 \times 10^{-5} \text{ m} = 0.00981 \text{ cm}$ (Answer)

4. Write down the Bernoulli's equation for ideal and real fluid.

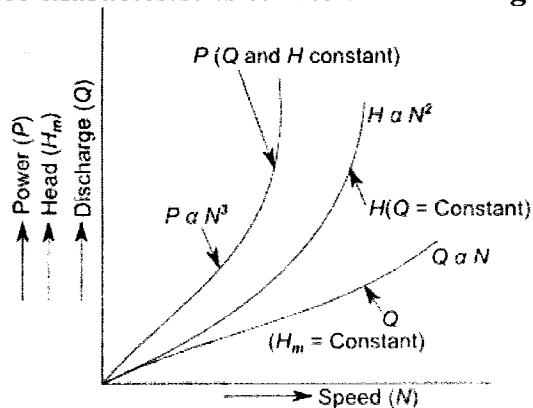
Bernoulli's Equation for ideal fluid:

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2$$

Bernoulli's Equation for real fluid:

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 + h_f$$

5. Draw the performance characteristics curves of a centrifugal pump.



Main characteristics curves of a pump.

6. A centrifugal pump is used to raise water at a height of 100 ft with discharge of 2.0 cusec. The efficiency of the pump is 62 %. Find the input horse power of the pump.

Solution: Given, $H=100\text{ft}=30.48$ meter; $Q=2.0$ cusec = 0.057 m³/sec; $\eta=62\%$; $\rho=1000$ m³/sec

$$\begin{aligned} P &= \rho g Q H / \eta \\ &= (1000 \times 9.81 \times 0.057 \times 30.48) / 0.62 \\ &= 27.5 \text{ KW} = 36.88 \text{ hp (Answer)} \end{aligned}$$

7. An ice plant produces 100 tons of ice in 24 hrs. If the plant uses water at 20⁰ C, find its cooling capacity. Specific heat and latent heat of solidification of water are 4.2 kJ/kg/K and 334 kJ/kg respectively.

Solution:

Here, $m=100\text{tons}=100 \times 1000\text{Kg}$; $t=24\text{hrs}=24 \times 60$ sec; $S_w=4.2\text{KJ/Kg}$; $L_w=334\text{KJ/Kg}$

$$\begin{aligned} \text{Cooling Capacity} &= \frac{m L_f}{24 \times 60} + \frac{m S_w \Delta T}{24 \times 60} \\ &= \frac{100 \times 1000 \times 334}{24 \times 60} + \frac{100 \times 1000 \times 4.2 \times 20}{24 \times 60} \\ &= 23194.44 + 5833.33 \text{ KJ/min} \\ &= 138.23 \text{ TR (Answer)} \end{aligned}$$

8. What are the functions of an economizer and safety valve in a boiler?

Answer: Economizer:

An economizer is a device used to heat feed water by utilizing the heat in the exhaust flue gases before leaving through the chimney. As the name indicates, the economizer improves the economy of the steam boiler.

Safety Valve:

• The safety valve (pressure relief valve) is used in a boiler to relieve the pressure of steam when it is above the working pressure.

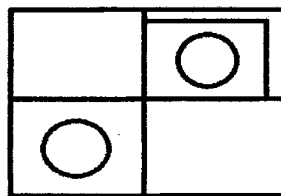
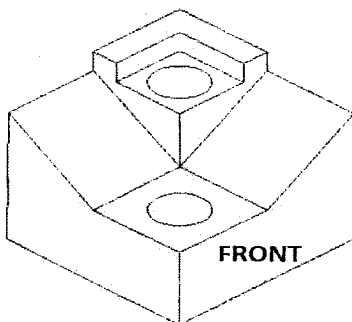
- Its function is to discharge a portion of the steam from the boiler automatically when the steam pressure exceeds the normal limit. It is mounted on the top of the shell.
- As per boiler regulation two safety valves are required to be fitted in each boiler.

9. How do you identify a petrol engine and a diesel engine?

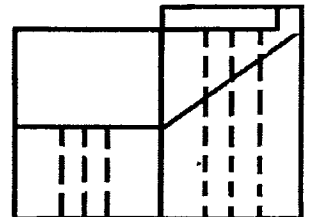
Answer:

Diesel engines are compression ignition and petrol engines are spark ignited one. If there is a spark plug its petrol engine or else it would be diesel engine. The presence of fins in the engine compartment also differentiates them apart as Diesel engines have and petrol does not.

10. Draw the TOP and FRONT views of the following block. Holes are through the height.



TOP VIEW



FRONT VIEW

Encircle the most appropriate answer.

$$20 \times 1 = 20$$

11. In a thin-walled pressure cylinder the ratio of longitudinal stress to the hoop stress is
- 0.5
 - 2.0
 - 1.0
 - 4.0
12. Every cross-section of a shaft, which is subjected to a twisting moment, is under
- compressive stress
 - shear stress**
 - tensile stress
 - bending stress
13. If a member is subjected to an axial tensile load, the plane inclined at 45° to the axis of loading carries
- minimum shear stress
 - maximum shear stress
 - minimum normal stress
 - maximum normal stress**
14. Which of the following parts of an engine may be considered as a column?
- crankshaft
 - cam shaft
 - connecting rod**
 - piston

15. The objective of a flywheel in an engine is to
- perform balancing
 - increase the power generation
 - reduce energy fluctuation**
 - increase energy fluctuation
16. A coil of stiffness k is cut into two halves. The stiffness of the cut coils will be
- same
 - half
 - double**
 - one-fourth
17. The size of a gear is usually specified by the
- pressure angle
 - circular pitch
 - pitch circle diameter**
 - diametral pitch
18. Continuity equation deals with the law of conservation of
- mass**
 - energy
 - momentum
 - none of the above
19. Compression ratio of diesel engine varies from
- 6 to 10
 - 10 to 15
 - 15 to 25**
 - 25 to 30
20. Which is not the mounting in a boiler?
- safety valve
 - super heater**
 - fusible plug
 - water level indicator
21. What should be the relative humidity when the dry bulb and wet bulb temperature are same?
- 50 %
 - 75 %
 - 100 %**
 - 0 %
22. Fourier's law of heat conduction is
- $Q = KA \frac{dT}{dx}$
 - $Q = KA \frac{dx}{dT}$

c) $Q = K \frac{dT}{dx}$

d) none of the above

23. Dry bulb and wet bulb temperatures are equal at

(a) 90 % relative humidity

(b) 75 % relative humidity

(c) 50 % relative humidity

(d) none of the above

24. Air conditioning means

(a) cooling and dehumidifying

(b) heating and humidifying

(c) supplying quality air

(d) all of the above

25. Bangladesh produces most of its electric power using

(a) gas turbine

(b) steam turbine

(c) wind turbine

(d) water turbine

26. Which of the following pump is a positive displacement type?

a) centrifugal pump

b) reciprocating pump

c) axial flow pump

d) mixed flow pump

27. Surge tank in a pipe line is used to

a) reduce the loss of head due to friction in pipe

b) make the flow uniform in pipe

c) relieve the pressure due to water hammer

d) none of the above

28. Orifice meter is used to measure

a) velocity of flow

b) flow rate of fluid

c) both flow rate and velocity of flow

d) static pressure of the flow

29. The head loss in elbow is

a) higher than that in bend.

b) lower than that in bend

c) same as in bend

d) none of the above

30. Rotameter is used to measure

a. flow rate of fluid

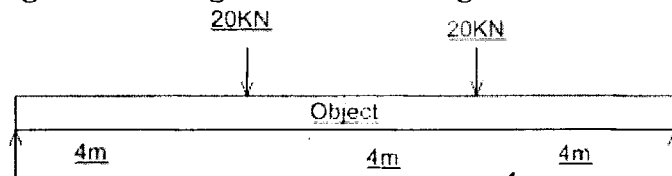
b. velocity of fluid

c. density of fluid

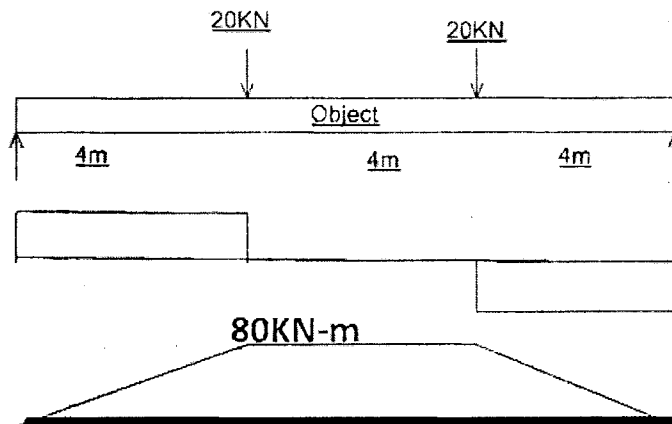
d. viscosity of fluid

Bangladesh Petroleum Exploration & Production Company Limited (BAPEX)-2016

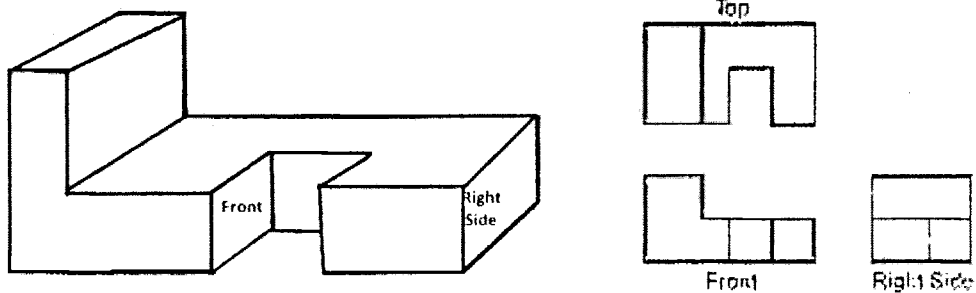
1. Draw the bending moment diagram of the beam given below:



Answer:

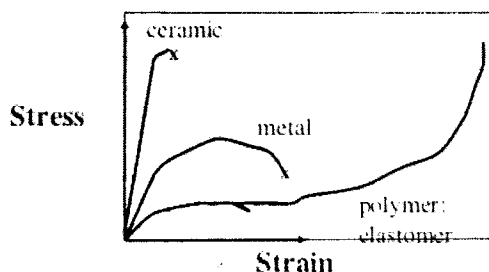


2. Draw the LHS and FRONT view.



3. Draw stress-strain curve for steel, ceramic and polymer materials.

Answer:



4. What is boiler power? Convert 1BHP of boiler into Kg/hr.

Answer: One boiler horsepower is the amount of energy required to produce 34.5 pounds (15.65 kg) of steam per hour at pressure and temperature 0 psig (0 bar) and 212° F (100°C) - with feed water at pressure 0 psig and temperature 212° F.

1 BHP = 15.65 Kg/hr

5. Name five names of energy storing technologies.

Answer:

Solid state batteries: a range of electrochemical storage solutions, including advanced chemistry batteries and capacitors.

Flow Batteries: batteries where the energy is stored directly in the electrolyte solution for longer cycle life and quick response time.

Flywheels: mechanical devices that harness rotational energy or deliver instantaneous electricity.

Compressed air energy storage: Utilizing compressed air to create a potent energy reserve.

Thermal: Capturing heat and cold to create energy on demand.

Pumped hydro power: creating large scale reservoirs of energy with water.

6. A vapor compression refrigeration cycle has the cooling capacity of 2 ton. Find the compressor power if the COP is 3.5.

Answer: We know, $COP = \frac{\text{Cooling Capacity}}{\text{Compressor Power}}$

$$\text{Compressor power} = \frac{\text{Cooling Capacity}}{COP} = \frac{2 \text{ ton}}{3.5} = \frac{2 \times 3.5}{3.5} = 2 \text{ KW (Answer)}$$

7. What is LMTD? Write the equation for LMTD.

Answer: Logarithmic mean temperature difference (LMTD) is defined as that temperature difference which, if constant, would give the same rate of heat transfer as actually occurs under variable conditions of temperature difference. The larger the value of LMTD, the higher heat is transferred. The rate of heat transfer can be expressed as

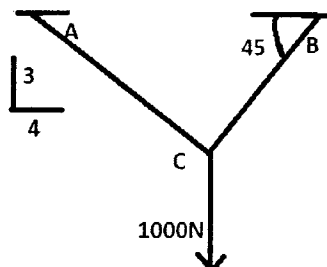
$$q = UA\Delta T_m$$

Where ΔT_m is the logarothomic mean temperature difference given as

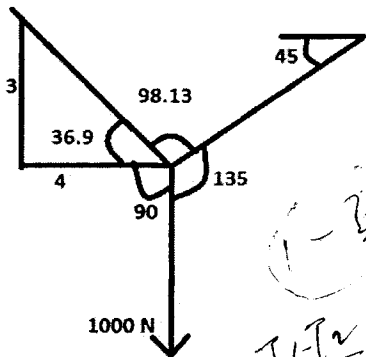
$$\Delta T_m = \frac{\Delta T_1 - \Delta T_2}{\ln \frac{\Delta T_1}{\Delta T_2}}$$

Parallel flow Heat exchangers	Counter flow heat exchanger
$\Delta T_1 = T_{\text{hot,in}} - T_{\text{cold,in}}$	$\Delta T_1 = T_{\text{hot,in}} - T_{\text{cold,out}}$
$\Delta T_2 = T_{\text{hot,out}} - T_{\text{cold,out}}$	$\Delta T_2 = T_{\text{hot,out}} - T_{\text{cold,in}}$

8. Find tension at AC.



Solution :



We get, from Lami's theorem,

$$\frac{T_{AC}}{\sin 135^\circ} = \frac{1000}{\sin 98.13^\circ}$$

$$\therefore T_{AC} = 714.3 \text{ N (Answer)}$$

9. Write two fundamental assumptions of Bernoulli's equation. A fluid flows with a pressure of 6MPa and velocity of 1m/s. In a nozzle it expands and pressure becomes the atmospheric. Find the velocity after expansion; datum is same.

Answer:

Assumptions: 1. the fluid is ideal, i.e. viscosity is zero.

2. The flow is incompressible and steady and irrotational.

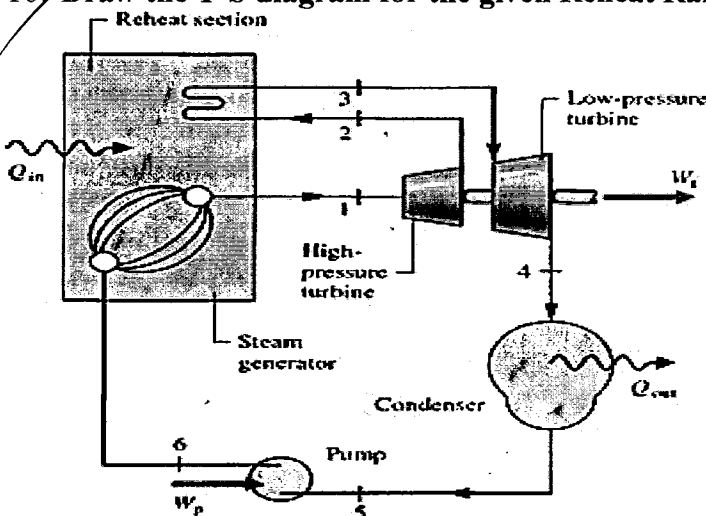
We know, $P_1 + \frac{1}{2} \rho V_1^2 + \rho gh_1 = P_2 + \frac{1}{2} \rho V_2^2 + \rho gh_2$ Let, Density of these fluid = 1000 Kg/m^3
Here,

$V_1 = 1 \text{ m/s}$, $P_1 = 6 \text{ MPa} = 6 \times 10^6 \text{ Pa}$, $P_2 = 101325 \text{ Pa}$, $V_2 = ?$ $h_1 = h_2$

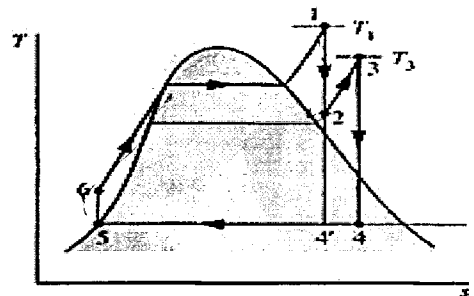
$$\therefore 6 \times 10^6 + \frac{1}{2} \times 1000 \times 1^2 = 101325 + \frac{1}{2} \times 1000 \times V_2^2$$

or, $V_2 = 108.62 \text{ m/s (Answer)}$

10. Draw the T-S diagram for the given Reheat Rankine cycle.

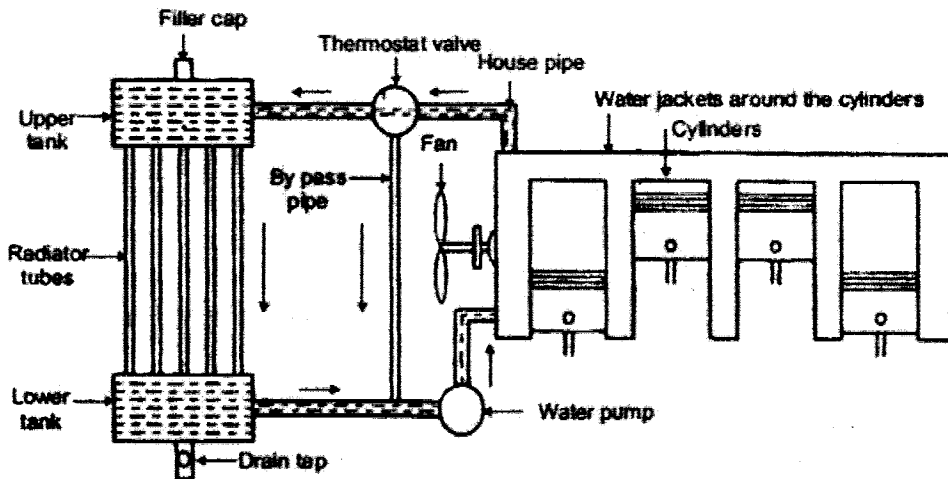


Answer



11. Draw a cooling circuit of a car.

Answer:



12. Write name of three theories of failure of ductile materials and two theories of brittle materials.

Answer:

Theories of ductile failure (yielding):

- 1) Maximum shear stress theory,
- 2) Maximum strain energy theory, and (3) maximum distortion energy theory.

Theories of brittle failure (yielding):

- 1) maximum normal stress theory,
- 2) Coulomb-Mohr theory

Bangladesh Industrial and Technical Assistance Centre (BITAC)

Post: Junior Engineer(Mechanical)

Time-10.00AM to 11.30AM

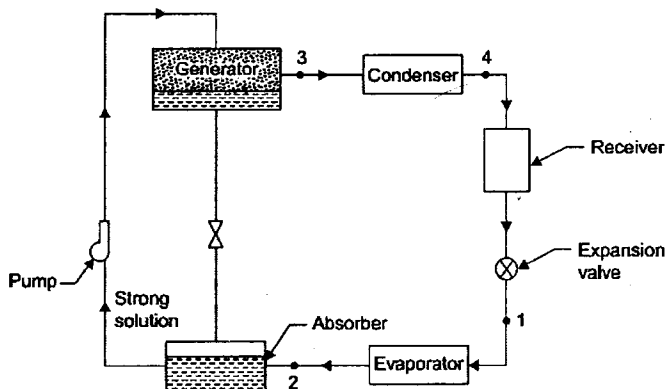
Date:29.04.2016

Exam Hall: CE Building, BUET

[Technical Question Only]

1. The condition of stable equilibrium for a floating body is
 - a) the metacenter coincides with the center of gravity
 - b) the metacenter is below center of gravity**
 - c) the metacenter is above center of gravity
 - d) the center of buoyancy is above the center of gravity
2. When the pipes are connected in parallel, the total loss of head
 - a) is equal to the sum of the loss of head in each pipe
 - b) is same as in each pipe**
 - c) is equal to the reciprocal of the sum of the loss of head in each pipe
 - d) none of the above
3. Which one is correct for a column of fixed-free end?
 - a) $\frac{\pi^2 EI}{l^2}$
 - b) $\frac{\pi^2 EI}{2l^2}$
 - c) $\frac{\pi^2 EI}{4l^2}$
 - d) $\frac{2\pi^2 EI}{l^2}$
4. For two elastic body the coefficient of restitution is-
 - a) Zero
 - b) 0.5
 - c) $\frac{2}{3}$
 - d) 1**
5. For heat conduction $k = 390 \text{ W/mk}$. Heat rate $6 \text{ MJ/m}^2\text{S}$. What is the value of temperature gradient?
 - a) $3.3 \times 10^4 \text{ K/m}$
 - b) $2.3 \times 10^4 \text{ K/m}$
 - c) $1.54 \times 10^1 \text{ K/m}$
 - d) $1.54 \times 10^4 \text{ K/m}$**
6. Which is correct for Maximum torsional shearing stress –
 - a) TJ/r
 - b) Tr/J**
 - c) Tr/l
 - d) $\frac{16PR}{\pi D^3} (1 + \frac{d}{4R})$
7. Pelton Wheel is a –
 - a) Axial flow reaction turbine
 - b) Radial flow reaction turbine
 - c) Reaction turbine
 - d) Impulse turbine**
8. For turbulent flow Reynolds number is-
 - a) $Re > 2000$
 - b) $Re < 2000$
 - c) $Re > 2300$
 - d) $Re > 4000$**
9. Draw the schematic diagram of a vapor absorption refrigeration cycle.

Answer:



10. A gas turbine works on Brayton cycle. Air intake temperature is atmospheric and the compressor outlet is 1.6Mpa. Find the efficiency.

Solution:

Given, $P_1 = 101325 \text{ Pa}$, $P_2 = 1.6 \times 10^6 \text{ Pa}$;

$$\text{Pressure ratio, } r = \frac{P_2}{P_1} = \frac{1.6 \times 10^6}{101325} = 15.79$$

$$\therefore \eta = 1 - \frac{1}{r^{\gamma-1/\gamma}} = 1 - \frac{1}{15.79^{0.4/1.4}} = 0.5454$$

$$\therefore \eta = 54.54\% \text{ (Answer)}$$

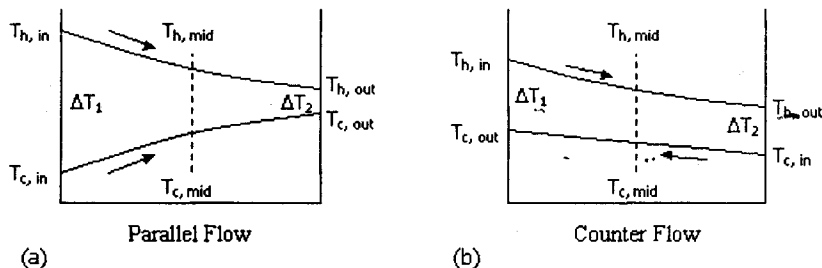
11. Write the process of gas turbine efficiency improvement.

Answer:

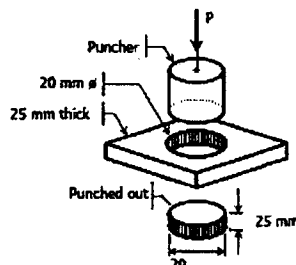
1. Reducing the Compressor Work by making the compression process close to isentropic in nature. This can be done by insulating the body of the Compressor and preventing exchange of heat as much as possible, though reversibility is practically impossible to achieve.
2. Designing the entire Gas Power Cycle for operating on higher pressure ratios. This would increase the temperature of the end state of the gas, after addition of heat, thus enabling greater amount of expansion in the Turbine and hence, more power. However, this is restricted by the Material Properties used in the equipment.
3. Preheating the air before entering the compressor, as it would decrease the compressor work required.
4. Usage of Regenerative Cycle Heat Transfer, and utilizing the heat lost in exhaust gases.
5. Reheating the gas during the Expansion Process, or at least a part of it.

12. Draw the temperature distribution for parallel flow and counter flow heat exchangers.

Answer:

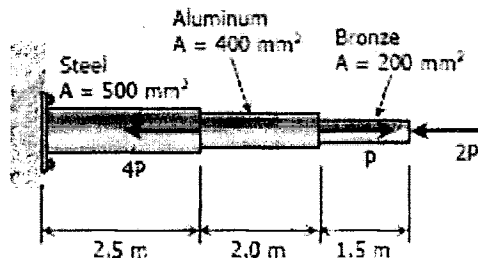


13. What force is required to punch a 20-mm-diameter hole in a plate that is 25 mm thick? The shear strength is 350 MN/m^2 .



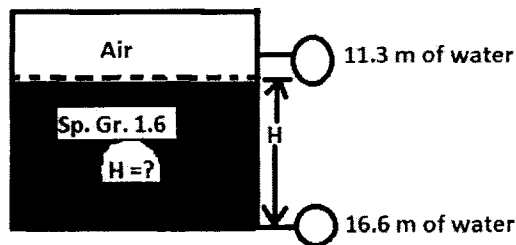
Solution: We get, $P = 350 \times \pi \times 20 \times 25 = 549778.7\text{N} = 549.8\text{KN}$ (Answer)

14. Find the stress of the steel section. P is equal to 1KN.



Answer: We get, $\sigma = \frac{5P}{A} = \frac{5 \times 1000}{500 \times 10^{-6}} = 10\text{MN/m}^2$ (Answer)

15. Find the value of H. The specific gravity of the liquid is 1.6.



Solution: We get, $P_1\gamma + H\gamma = P_2\gamma$

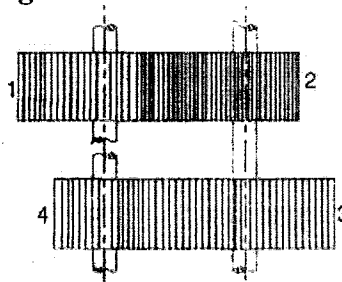
or, $(11.3 \times 1) + (H \times 1.6) = (16.6 \times 1)$

or, $H = 3.31\text{ m}$ (Answer)

16. A pipe of 300m long having diameter 50mm of velocity 2m/s^2 . Find the head loss of the pipe. The friction factor is 0.004.

Solution: We know, $H_f = \frac{fv^2}{2gd} = \frac{0.004 \times 300 \times 2^2}{2 \times 9.81 \times 0.05} = 4.89$ (Answer)

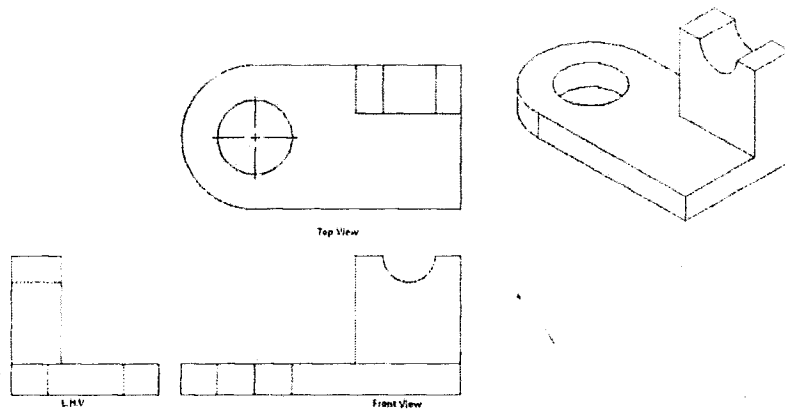
17. In an inverted gear, gear 1 drives gear 2, gear 2 drives gear 3, gear 3 drives gear 4. The number of teeth of gears 1, 2, 3 and 4 respectively _____. The speed of gear 1 is 360 rpm, find the speed of the 6th gear.



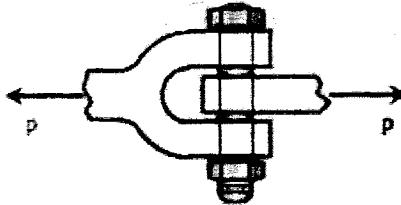
Solution Hints:

$$\frac{N_A}{N_B} = \frac{T_B}{T_A} \text{ and so on...}$$

18. Draw TOP VIEW, Front VIEW and L.H.S. VIEW without dimension.



19. Find the smallest diameter bolt that can be used in the clevis shown in Fig. if $P = 400$ kN. The shearing strength of the bolt is 300 MPa. Factor of safety is 3.

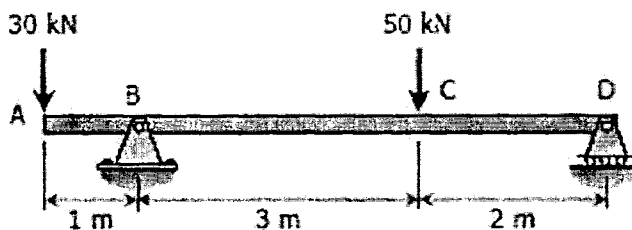


Solution: Here, the bolt is subjected to double share.

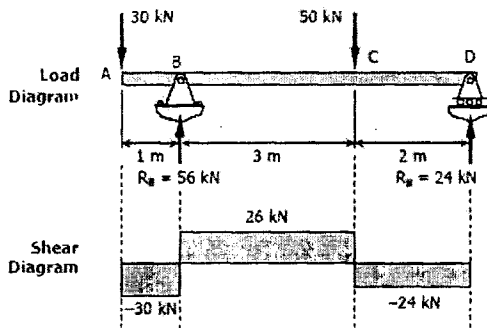
$$\text{We get, } 400 \times 1000 = \frac{300}{3} \times 2 \times \frac{1}{4} \pi D^2$$

$$\Rightarrow D = 50.46 \text{ mm (Ans.)}$$

20. Draw the SFD of the beam shown in below.



Answer:



From the load diagram:

$$\sum M_B = 0$$

$$5R_D + 1 \times 30 = 3 \times 50$$

$$R_D = 24 \text{ kN}$$

Again,

$$\sum M_D = 0$$

$$5R_B = 2 \times 50 + 6 \times 30$$

$$R_B = 56 \text{ kN}$$

Bangladesh Inland Water Transport Authority (BIWTA)
Post: Assistant Manager (Mechanical)
Exam Hall: BUET

15 × 4 = 60

1. What is “ton of refrigeration”?

Answer: Ton of refrigeration/TR: A ton of refrigeration is defined as the amount of refrigeration effect produced by the uniform melting of one ton (1000kg) of ice from and at 0 degree centigrade in 24 hours.

$$1\text{TR} = 210 \text{ kJ/min} = 3.5 \text{ kW}$$

2. Define boiler mountings and accessories with examples.

Answer: Mountings: Mountings are required for proper and safe functioning of the boiler which is generally mounted over the boiler shell.

Example: 1. Water level indicator, 2. Pressure Gauge and 3. Safety valves

Accessories: These are the devices which are used as integral parts of boiler and help in running efficiently.

Example: 1. Super heater, 2. Economiser and 3. Air Preheater

3. Write down the 1st and 2nd law of thermodynamics.

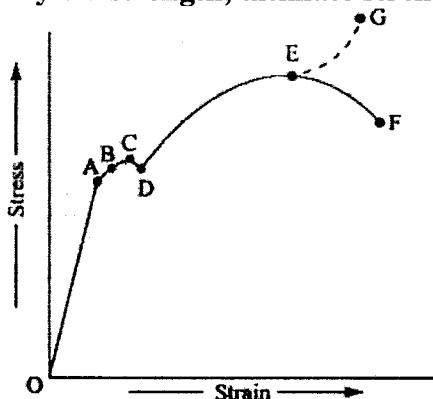
Answer: First Law of Thermodynamics: a) The heat and mechanical work are mutually convertible. i.e. $\oint dQ = \oint dw$.

b) The energy can neither be created nor destroyed though it can be transformed from one to another. i.e. $\delta Q - \delta W = \delta E$

Second Law of Thermodynamics: According to Kelvin-Planck- “It is impossible to construct an engine working in a cyclic process whose sole purpose is to convert heat energy into an equivalent amount of work.”

Clausius Statement: It is impossible for a self-acting machine working in a cyclic process to transfer heat from a body at a lower temperature to a body at a higher temperature without the aid of an external agency.

4. Draw the typical stress-strain diagram of mild steel showing proportional limit, yield strength, ultimate strength and breaking strength on it.



- A- Proportional limit
- B- Elastic limit
- C- Upper yield point
- D- lower yield point
- E- Ultimate stress/strength
- F- Breaking stress/strength
- G- Actual Rupture Strength

5. Define modulus of elasticity and modulus of rigidity. For a material which one is greater?

Answer: Modulus of elasticity: Hook's law states that when a material is within elastic limit, the stress is directly proportional to strain.

i.e., $\sigma \propto \epsilon$; $\sigma = E\epsilon \therefore E = \frac{\sigma}{\epsilon}$

Where, E is a constant of proportionality and known as Young's Modulus or modulus of elasticity.

Modulus of rigidity or shear modulus: It is found experimentally that within elastic limit shear stress is directly proportional to shear strain. Mathematically, $\tau \propto \phi$; or, $\tau = C \phi$

Where, τ = shear stress; ϕ = shear strain and C = constant of proportionality, known as Modulus of rigidity or shear modulus. It also denoted by N or G.

6. A solid steel shaft in a rolling mill transmits 20 kW at 2 Hz. Determine the diameter of the shaft if the shearing stress is not to exceed 40 MPa.

Solution: Given, P = 20 KW, f = 2Hz, $\tau = 40 \text{ MPa}$

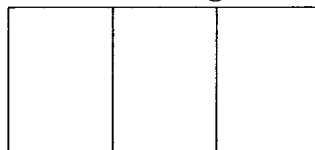
We Know, $T = \frac{P}{2\pi f} = \frac{20000}{2 \times 3.1416 \times 2} = 1591.55 \text{ N-m.}$

Again, we get, $\tau = \frac{16T}{\pi d^3}$

$$\Rightarrow 40 \times 10^6 = \frac{16 \times 1591.55}{\pi d^3}$$

$\Rightarrow d = 58.7 \text{ mm (Answer)}$

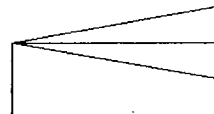
7. Draw the isometric view for the given TOP VIEW, FRONT VIEW and RHS VIEW.



TOP VIEW

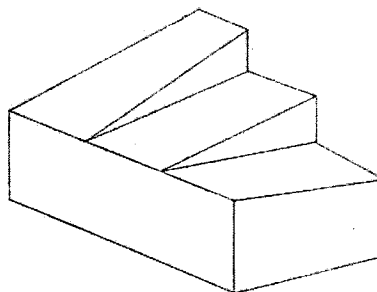


FRONT VIEW

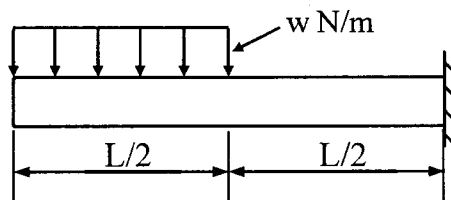


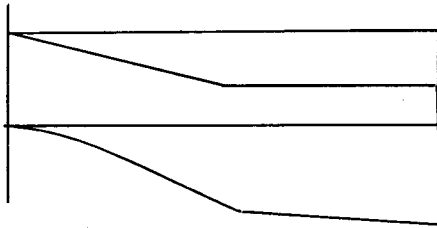
RHS VIEW

Answer:



8. A uniformly distributed load of magnitude w is applied over the whole span of a simply supported beam of length L. Draw the shear force and bending moment diagrams of the beam.





9. A furnace wall of thickness 1 m and of surface area 2 m^2 is made of a material whose thermal conductivity is 20 W/mK . The temperatures of the inner and outer surfaces of the wall are 1000°C and 200°C respectively. Determine the heat flow through the wall.

Solution:

We know, $Q = kA \frac{dT}{dx}$

Here, $dx = 1 \text{ m}$, $A = 2 \text{ m}^2$, $K = 20 \text{ W/mK}$, $dT = (1000 - 200)^\circ\text{C} = 800^\circ\text{C}$

$$\therefore Q = kA \frac{dT}{dx} = 20 \times 2 \times \frac{800}{1} = 32000 \text{ W} = 32 \text{ KW (Answer)}$$

Tick on the most appropriate answer

$$20 \times 1 = 20$$

10. The velocity of a body on reaching the ground from a height h is

- a) $2\sqrt{gh}$
- b) \sqrt{gh}
- c) $\sqrt{2gh}$
- d) $2g\sqrt{h}$

11. Which machine is used to cut gears?

- (a) lathe machine
- (b) vertical milling machine
- (c) shaper machine
- (d) none of the above

12. A coil of stiffness k is cut into two halves. The stiffness of the cut coils will be

- (a) Same
- (b) Half
- (c) Double
- (d) one-fourth

13. In thin cylinder the ratio of longitudinal stress to the hoop stress is

- a) 0.5
- b) 2.0
- c) 1.0
- d) 4.0

14. The size of a gear is usually specified by the

- a) pressure angle
- b) circular pitch

- c) pitch circle diameter
 - d) diametral pitch
15. Bangladesh produces most of its electric power using
- a) gas turbine
 - b) steam turbine
 - c) gas engine
 - d) water turbine
16. Dry bulb and wet bulb temperatures are equal at
- a) 90 % relative humidity
 - b) 75 % relative humidity
 - c) 50 % relative humidity
 - d) none of the above
17. The amount of radiation mainly depends upon the
- a) nature of the body
 - b) temperature of the body
 - c) type of surface of the body
 - d) all of the above
18. Air conditioning means
- a) cooling and dehumidifying
 - b) heating and humidifying
 - c) supplying quality air
 - d) all of the above
19. An additional mass is used in the crankshaft of an IC engine with a view to
- a) strengthening the crankshaft
 - b) balancing the crankshaft
 - c) strengthening and balancing the crankshaft
 - d) none of the above
20. Which of the following parts of an engine may be considered as a column?
- a) Crankshaft
 - b) cam shaft
 - c) connecting rod
 - d) piston
21. Which one of the following is not a refrigerant?
- a) CO_2
 - b) H_2O
 - c) NH_3
 - d) CCl_3
22. Which of the following will have least value of thermal conductivity?
- a) copper
 - b) silver
 - c) glass
 - d) air
23. Essential requirement for the transfer of heat from one body to another is
- a) both bodies must be solids
 - b) both bodies must be in contact

- c) temperature of the two bodies must be different
- d) one of the bodies must have internal source of heat generation

24. When connected to the engine, the tachometer measures

- a) engine torque
- b) engine rpm
- c) engine compression
- d) engine vacuum

25. The modulus of elasticity (E) and modulus of rigidity (G) are related by

a) $G = \frac{E}{2(1+\nu)}$

b) $G = \frac{E}{2(1-\nu)}$

c) $E = \frac{G}{2(1+\nu)}$

d) none of the above

$$G = \frac{E}{2(1+\nu)}$$

where ν is the Poisson's ratio.

BANGLADESH RURAL ELECTRIFICATION BOARD (BREB)**Recruitment Examination for Assistant Engineer (Mechanical)****Subject code: ২ Marks 60(Each question bears equal value)****Time: 45 Minute**

- 1 The maximum deflection of a fixed beam carrying a central point load lies at
a) Fixed ends b) Centre of beam
c) L/3 from fixed ends
d) None of these
- 3 Bernoulli's equation is applied to
a) Venturimeter
b) Orifice meter
c) Pitot meter
d) All of these
- 5 Reynold's number is the ratio of inertia force to-
a) Pressure force
b) Elastic force
c) Gravity force
d) Viscous force
- 7 A Pelton wheel develops 1750 kW under a head of 100 meters while running at 200 r.p.m. and discharging 2500 litres of water per second. The unit power of the wheel is
a) 0.25kW b) 0.75kW c) 1.75kW d) 3.75kW
- 9 A hydraulic coupling belongs to the category of
a) Power absorbing machines
b) Power developing machines
c) Energy transfer machine
d) Energy generating machine
- 11 The sum of internal energy (U) and product of pressure and volume (p.v) is known as
a) Workdone b) Entropy
c) Enthalpy d) None of these
- 13 The fitting mounted on the boiler for its proper and safe functioning is a
a) Water level indicator
b) Fusible plug
c) Safety valve
d) All of those
- 15 A device in which some portion of waste heat of flue gases is recovered to heat the air before it passes to the furnace for combustion purpose, is known as
a) Superheater b) Air preheater
c) Economizer d) Injector
- 2 Rankine's formula holds good for
a) A short columns
b) A long columns
c) both short & columns
d) weak columns
- 4 The velocity at which the flow changes from laminar flow to turbulent flow is called -
a) Critical velocity
b) Velocity of approach
c) Sub-Sonic of approach
d) Super-sonic velocity
- 6 The speed of turbine runner is
a) Directly proportional to $H^{1/2}$
b) Inversely proportional to $H^{1/2}$
c) A directly proportional to $H^{1/2}$
d) Inversely proportional to $H^{3/2}$
- 8 The discharge of a double Acting reciprocating pump is
a) L.A.N. b) 2 L.A.N.
c) $\frac{L.A.N}{60}$ d) $\frac{2 L.A.N}{60}$
- 10 Energy can neither be created nor destroyed, but it can be transformed from one form to another. This statement is known as
a) Zeroth law of thermodynamics
b) First law of thermodynamics
c) Second law of thermodynamics
d) Kinetic theory of gases
- 12 The comparison ratio for petrol engine is-
a) 3 to 6 b) 5 to 8
c) 15 to 20 d) 20 to 30
- 14 A device used to increase the temperature of saturated steam without raising its pressure is called,
a) Blow off cock b) Fusible plug
c) Superheater d) Stop valve
- 16 Steam turbines may be classified according to
a) Direction of steam flow
b) Number of stages
c) Mode of steam action
d) All of these

Fundamentals of Mechanical Engineering

WB-1.20 $\frac{50}{60} \times 2\pi$ QB-77

17 The blade friction in the impulse turbine reduces the velocity steam by..... while it passes over the blades

- a) 10 to 15%
- b) 15 to 20%
- c) 20 to 30%
- d) 30 to 40%

19 The value of the reheat factor varies from

- a) 1.02 to 1.06
- b) 1.08 to 1.10
- c) 1.2 to 1.6
- d) 1.6 to 2

21 The basic requirement of a good combustion chamber is.

- a) Minimum turbuience
- b) Low compression ratio
- c) High thermal efficiency and power output
- d) Low volumetric efficiency

23 A power plant giving least running cost of production of electrical power is

- a) Steam power plant
- b) Gas turbine power plant
- c) Hydroelectric power plant
- d) Nuclear power plant

5 A close cycle gas turbine works on

- a) Camot cycle
- b) Rankine cycle
- c) Ericsson cycle
- d) Joule cycle

27 Air refrigeration cycle is used in

- a) Commercial refrigerators
- b) Domestic refrigerators
- c) Air-conditioning
- d) Gas liquefaction

29 The arrangement is called bevel gearing, when two are connected by gears

- Intersecting and coplanar shaft
- Non-Intersecting and non-coplanar shafts
- Parallel and coplanar shafts
- Parallel and non-coplanar shafts

31 Gears are caused by

- a) Sand mould casting
- b) Slush casting
- c) Permanent mould casting
- d) Centrifugal casting

33 Which of the following is a case hardening process?

- a) Carburising
- b) Cyaniding
- c) Nitriding
- d) All to these

18 A single stage impulse turbine with a diameter of 1.2m runs at 3000 r.p.m. If the blade speed ratio is 0.42, then the inlet velocity of steam will be

- a) 79m/s
- b) 188m/s
- c) 450m/s
- d) 900m/s

20 The knocking tendency in spark ignition engines may be decreased by

- a) controlling the air-fuel mixture
- b) Controlling the ignition timing
- c) Controlling the exhaust temperature
- d) Reducing the compression ratio.

The brake power (B.P) of the engine is given by

- a) $B.P = \frac{W \times 2\pi N}{60}$ watts
- b) $B.P = \frac{(W-S)\pi D N}{60}$ watts
- c) $B.P = \frac{(W-S)\pi(D+d)N}{60}$ watts
- d) All of these

24 If the flow of air through the compressor is perpendicular to its axis, then it is a

- a) Reciprocating compressor
- b) Centrifugal compressor
- c) Axial flow compressor
- d) Turbo compressor

In a shell and tube heat exchanger, baffles are provided on the shell side to

- a) Improve heat transfer
- b) Provide support for tubes
- c) Prevent stagnation of shell side fluid
- d) All of these

The heat rejection factor (HRF) is given by

- a) $1 + C.O.P$
- b) $1 - C.O.P$
- c) $1 + \frac{1}{C.O.P}$
- d) $1 - \frac{1}{C.O.P}$

30 Which of the following is used to control the speed variation of the engine caused by the fluctuation of the engine turning moment?

- a) D-slide valve
- b) Governor
- c) Flywheel
- d) Meyer's expansion valve

32 The percentage of carbon in cast iron varies from

- a) 0.1 to 0.5
- b) 0.5 to 1
- c) 1 to 1.7
- d) 1.7 to 4.5

34 The sand used for making cores is

- a) Green sand
- b) Dry sand
- c) Loam sand
- d) Oil sand

35 A casting defect which occurs due to improper venting of sand is known as a) Cold shuts
b) Blow holes c) Shift d) Swell

37 The purpose of jigs and fixture is to
a) Increase machining accuracy
b) Facilitate interchangeability
c) Decrease expenditure on quality control
d) All of these.

39 The purpose of transmission in an automobile is
a) To vary the speed of automobile
b) To vary the torque at the wheels
c) To vary the power of automobile
d) None of these

41 বাংলা নববর্ষ পহেলা বৈশাখ চালু করেছিলেন?
ক) ফখরুদ্দিন মোবারক শাহ
খ) ইলিয়াস শাহ
গ) সম্রাট আকবর
ঘ) সম্রাট বাবুর

43 স্বাধীনতা হীনতায় কে বাঁচিতে চায়, চরণটি কার রচনা?
ক) ঈশ্বরচন্দ্র গুপ্ত
খ) মধুসূদন দত্ত
গ) হেমচন্দ্র বন্দ্যোপাধ্যায়
ঘ) রঞ্জলাল বন্দ্যোপাধ্যায়

45 উপসর্গের কাজ কি?
ক) নতুন শব্দ গঠন করা
খ) বিভক্তিরূপ নির্ধারণ করে
গ) যতি সংস্করণ করে
ঘ) সর্বনাম তৈরি করে

47 কম্পিউটার নেটওয়ার্কের ক্ষেত্রে নিচের কোন মাধ্যমটি সর্বাপেক্ষা দ্রুত তথ্য পরিবহনে সক্ষম?
ক) কো-এক্সিয়াল ক্যাবল
খ) ফাইবার অপটিক ক্যাবল
গ) টুইস্টেড পেয়ার ক্যাবল
ঘ) আর জে ৪৫ কানেক্টর

49 ফেয়ার ফ্যাক্স কি?
ক) সংবাদ সংস্থা খ) পরিবেশ সংস্থা
গ) গোয়েন্দা সংস্থা ঘ) মানবধিকার সংস্থা

51 We should abstain ----- smoking
a) of b) for
c) about d) from

53 The manager looked into the matter.
a) Take decision
b) Investigate
c) Neglect
d) Prudent

36 The cutting fluid mostly used for machining steel is
a) Water b) Soluble oil
c) Dry d) Heavy oils

38 Production cost refers to prime cost plus-
a) Factory overhead
b) Factory and administration overhead
c) Factory, administration and sales overhead
d) Factory, administration, sales overhead and profit.

40 Two advantages of using helical gears rather than spur in a transmission system are
a) Strength and cost
b) Strength and less and trust
c) Noise level and strength
d) Noise level and economy

42 অক্ষির সমীপে র সংক্ষেপ হলো
ক) সমক্ষ
খ) পরোক্ষ
গ) প্রত্যক্ষ
ঘ) নিরপেক্ষ

44 নিচের কোন কাজের জন্য কম্পিউটার বেশি সুবিধাজনক?
ক) পুনরাবৃত্তিমূলক কাজ
খ) প্রতিবেদন প্রণয়ন
গ) হিসাবরক্ষণ কাজ
ঘ) গাণিতিক কাজ

46 নিচের কোনটি সিস্টেম সফটওয়্যার?
ক) উইন্ডোজ ভিস্টা
খ) এমএস একসেল
গ) ওরাকল
ঘ) নোটপ্যাড

48 সাবশ বাংলাদেশ ভাস্কর্যটি কোথায় অবস্থিত?
ক) টিএসসির মোড়ে
খ) ঢাকা বিশ্ববিদ্যালয়ে
গ) রেসকোর্স ময়দানে
ঘ) রাজশাহী বিশ্ববিদ্যালয়ে

50 দহগ্রাম ছিটমহল কোন জেলায় অবস্থিত?
ক) কুড়িগ্রাম খ) নীলফামারী
গ) পঞ্চগড় ঘ) লালমনিরহাট

52 What is the synonym of 'Competent'
a) Circumspect b) PISCRETE
c) Capable d) Prudent

54 Find out the correct translation.
সকাল থেকে গুঁড়ি গুঁড়ি বৃষ্টি হচ্ছে
a) It is raining from morning
b) It has been raining from morning
c) It has been drizzling since morning
d) It is drizzling since morning

58 Who wrote "The beauty is truth is beauty."?

- a) Shakespeare b) wordsworth
c) Keats d) Eliot

57 বুকের পরিধি ও ব্যাসের অনুপাত

- ক) ২২/৭ খ) ১/৩
গ) ২২/৯ ঘ) ২৫/৯

59 একটি কুকুর একটি ভরগোশকে ধরার জন্য তাড়া করে। কুকুর যে সময় ৪ বার লাফ দেয়, খরগোশ সে সময় ৫ বার লাফ দেয়। কিন্তু খরগোশ ৪ লাফে যতদূর যায়, কুকুর ৩ লাফে ততদূর যায়। কুকুর ও খরগোশের গতিবেগের অনুপাত কত?

- ক) ১৫:১৬ খ) ২০:১২
গ) ১৬:১২ ঘ) ১২:২০

56 মূল বিন্দু O এবং $P=(x,y)$ হলে $OP=$ কত

- a) x^2+y^2 b) $\sqrt{x^2+y^2}$
c) $\sqrt{(x^2+y^2)^2}$ d) $x+y$

58 একটি দ্রব্য ৩৮০ টাকায় বিক্রয় করায় ২০ টাকা ক্ষতি হলো। ক্ষতির শতকরা হার কত?

- ক) ৪% খ) ৬% গ) ৫% ঘ) ৭%
৮, ১১, ১৭, ২৯, ৫৩ ... পরবর্তী সংখ্যা কত?
ক) ১০১ খ) ১০২
গ) ৭৫ ঘ) ৫৯

২০
৫/১০

ANSWER

1	B	11	C	21	C	31	C	41	গ	51	D
2	C	12	B	22	D	32	D	42	গ	52	C
3	D	13	D	23	D	33	D	43	ঘ	53	B
4	A	14	C	24	B	34	D	44	ক	54	C
5	D	15	B	25	D	35	B	45	ক	55	C
6	A	16	D	26	D	36	B	46	ক	56	B
7	C	17	A	27	D	37	D	47	খ	57	ক
8	D	18	C	28	C	38	A	48	ঘ	58	গ
9	C	19	A	29	A	39	B	49	ক	59	ঘ
10	B	20	D	30	C	40	C	50	ঘ	60	ক

$$4dx = 3dy \Rightarrow \left(\frac{d_1}{d_2}\right)$$

$$\frac{d_{avg}}{d_{avg}} = \frac{4 \times d_1}{5 d_2}$$

$$= \frac{4 \times 4}{5 \times 3} =$$

$$1 + \frac{1}{\omega p} = 1 + \frac{\omega}{\omega_1}$$

$$= \frac{\omega_1 + \omega}{\omega_1}$$

প্রাসঙ্গিক টেকনিক্যাল (BPSC)

বিষয় কোড-১০৫

শুধুমাত্র ইন্সট্রাক্টর (মেকানিক্যাল) পদের জন্য

(যেকোন চারটি প্রশ্নের উত্তর দিতে হবে)

মান-৬০

1. (a) What are the advantages and disadvantages of two stroke over four stroke cycle engine?

Answer: Advantages:

1. A two stroke cycle engine gives twice the number of power strokes than the four stroke cycle engine at the same engine speed. Theoretically, a two stroke cycle engine should develop twice the power as that of a four stroke engine. But in actual practice, a two stroke cycle engine develops 1.7 to 1.8 times (greater value for slow speed engines) the power developed by four stroke cycle engine of the same dimensions and speed. This is due to lower compression ratio and effective stroke being less than the theoretical stroke.
2. For the same power developed, a two-stroke cycle engine is lighter, less bulky and occupies less floor area. Thus it makes a two stroke cycle engine suitable for marine engines and other light vehicles.
3. As the number of working strokes in a two stroke cycle engine are twice than the four stroke cycle engine, so the turning moment of a two stroke cycle engine is more uniform. Thus it makes a two stroke cycle engine to have a lighter flywheel and fluctuations. This also leads to a higher mechanical efficiency of a two stroke cycle engine.
4. The initial cost of a two stroke engine is considerably less than a four stroke engine.
5. The mechanism of a two stroke engine is much simpler than a four stroke cycle engine.
6. The two stroke cycle engines are much easier to start

Disadvantages:

1. Thermal efficiency of a two stroke cycle engine is less than that a four stroke cycle engine, because a two stroke cycle engine has less compression ratio than that of a four stroke cycle engine.
2. Overall efficiency of a two stroke cycle engine is also less than that of a four stroke cycle engine because in a two stroke cycle engine, inlet and exhaust ports remain open simultaneously for some time. In spite of careful design, a small quantity of charge is lost from the engine cylinder.
3. In case of two stroke cycle engine, the number of power strokes is twice as those of a four stroke cycle engine. Thus the capacity of the cooling system must be higher. Beyond a certain limit, the cooling capacity offers a considerable difficulty. Moreover, there is a greater wear and tear in a two stroke cycle engine.
4. The consumption of lubricating oil is large in a two stroke cycle engine because of high operating temperature.
5. The exhaust gases in a two stroke cycle engine create noise, because of short available for their exhaust.

(b) What is meant by octane number of a fuel?

Answer: The percentage by volume of iso-octane in a mixture of iso-octane and normal heptane which exactly matches the knocking intensity of a given fuel in a standard engine under given standard operating conditions is termed as the octane number rating of that fuel.

(c) What is thermal efficiency of a standard Otto cycle for a compression ratio of 5.5?

Solution: Here, compression ratio, $r = 5.5$

$$\therefore \text{Thermal Efficiency, } \eta = 1 - \frac{1}{r^{\gamma-1}} = 1 - \frac{1}{5.5^{1.4-1}}$$

$$= 1 - 0.5056 = 0.4943 = 49.43\% \text{ (Answer)}$$

$$\eta = 1 - \frac{1}{5.5^{1.4-1}}$$

2. (a) What is priming of a centrifugal pump? How it is done?

Priming of centrifugal pump: Priming of a centrifugal pump is defined as the operation in which the suction pipe, casing of the pump and a portion of the delivery pipe upto the delivery valve is completely filled up from outside source with the liquid to be raised by the pump before starting the pump. Thus the air from these parts of the pump is removed and these parts are filled with the liquid to be pumped. When the pump is running in air, the head generated is in terms of metre of air. If the pump is primed with water, the head generated is same metre of water. But as the density of air is very low, the generated head of air in terms of equivalent metre of water head is negligible and hence the water may not be sucked from the pump. To avoid this difficulty, priming is necessary.

How it is done: In some cases pumps are primed by manually displacing the air in them with water every time the pump is restarted. Often, by using a foot valve or a check valve at the entrance to the suction pipe, pumps can be kept full of water and primed when not operating. If prime is lost, the water must be replaced manually, or a vacuum pump can be used to remove air and draw water into the pump.

A self-priming pump is one that will clear its passages of air and resume delivery of liquid without outside attention. Centrifugal pumps are not truly self-priming. So called self-priming centrifugal pumps are provided with an air separator in the form of a large chamber or reservoir on the discharge side of the pump. This separator allows the air to escape from the pump discharge and entraps the residual liquid necessary during re priming. Automatic priming of a pump is achieved by the use of a recirculation chamber which recycles water through the impeller until the pump is primed, or by the use of a small positive displacement pump which supplies water to the impeller.

(b) What is the function of air vessel in a reciprocating pump? What is NPSH?

Answer: Function of Air vessel:

Air vessel is fitted to the suction pipe and to the delivery pipe at a point close to the cylinder of a single-acting reciprocating pump:

- (i) To obtain a continuous supply of liquid at a uniform rate.
- (ii) To save a considerable amount of work in overcoming the frictional resistance in the suction and delivery pipes, and
- (iii) To run the pump at high speed without separation.

NPSH: The net positive suction head (NPSH) is defined as the difference between the net inlet head and the head corresponding to the vapor pressure of the liquid.

(c) A turbine develops 10,000KW under a head of 25m at 135rpm. What is the specific speed?

Solution: Here, $P = 1000\text{KW}$; $H = 25\text{ m}$; $N = 135\text{rpm}$.

$$\text{We know, } N_s = \frac{N\sqrt{P}}{H^{\frac{5}{4}}} = \frac{135\sqrt{1000}}{25^{\frac{5}{4}}} = 241.5 \text{ (SI Units) (Answer)}$$

3. (a) How steam boiler is classified? Differentiate between water tube and fire tube boiler?

Answer: Boilers Classification:

There are large number of boiler designs, but boilers can be classified according to the following criteria:

1. According to Relative Passage of water and hot gases:

1. Water Tube Boiler: A boiler in which the water flows through a number of small tubes which are surrounded by hot combustion gases, e.g., Babcock and Wilcox, Stirling, Benson boilers, etc.

2. Fire-tube Boiler: The hot combustion gases pass through the boiler tubes, which are surrounded by water, e.g., Lancashire, Cochran, locomotive boilers, etc.

2. According to Water Circulation Arrangement:

1. Natural Circulation: Water circulates in the boiler due to density difference of hot and water, e.g., Babcock and Wilcox boilers, Lancashire boilers, Cochran locomotive boilers etc.

2. Forced Circulation: A water pump forces the water along its path, therefore, the steam generation rate increases, Eg: Benson, La Mont, Velox boilers, etc.

3. According to the Use:

1. Stationary Boiler: These boilers are used for power plants or processes steam in plants.

2. Portable Boiler: These are small units of mobile and are used for temporary uses at the sites.

3. Locomotive: These are specially designed boilers. They produce steam to drive railway engines.

4. Marine Boiler: These are used on ships.

4. According to Position of the Boilers:

Horizontal, inclined or vertical boilers

5. According to the Position of Furnace

1. Internally fired: The furnace is located inside the shell, e.g., Cochran, Lancashire boilers, etc.

2. Externally fired: The furnace is located outside the boiler shell, e.g., Babcock and Wilcox, Stirling boilers, etc.

6. According to Pressure of steam generated

- Low pressure boiler: a boiler which produces steam at pressure of 15-20 bar is called a low-pressure boiler. This steam is used for process heating.

- Medium-pressure boiler: It has a working pressure of steam from 20 bar to 80 bar and is used for power generation or combined use of power generation and process heating.

- High-pressure boiler: It produces steam at a pressure of more than 80 bar.

- Sub-critical boiler: If a boiler produces steam at a pressure which is less than the critical pressure, it is called as sub-critical boiler.

▪ Super critical boiler: These boilers produce steam at a pressure greater than the critical pressure. These boilers do not have an evaporator and the water directly flashes into steam and thus they are called once through boilers.

7. According to charge in the furnace.

- Pulverized fuel,
- Supercharged fuel and
- Fluidized bed combustion boilers.

Difference between water tube boiler and fire tube boiler.

Water Tube Boiler	Fire Tube Boiler
• The water circulates inside the tubes which are surrounded by hot gases from the furnace.	• The hot gases from the furnace pass through the tubes which are surrounded by water.
• It generates steam at a highest pressure upto 165bar.	• It can generate steam only upto 24.5 bar. The rate of generation of steam is high i.e. upto 9 tonnes per hour.
• The rate of generation of steam is high i.e. upto 450 tonnes per hour.	• For a given power, the floor area required for the generation steam is less, i.e. about 8 m ² per tonne per hour of steam generation
• For a given power, the floor area required for the generation steam is less, i.e. about 5 m ² per tonne per hour of steam generation.	• Overall efficiency will economizer is upto 75%.
• Overall efficiency will economizer is upto 90%. It can be transported and erected easily as its various parts can be separated.	• The transportation and erection is difficult.
• It is preferred for widely fluctuating loads.	• It can also cope reasonably with sudden increase in load but for a shorter period.
• The direction of water circulation is well defined.	• The water does not circulate in a definite direction.
• The operating cost is very high.	• The operating cost is less.
• The bursting changes are more.	• The bursting changes are less.
• The bursting does not produce any destruction to the whole boiler.	• It is not suitable for large power plants.
• It is used for large power plants.	• The bursting produces greater risk to the damage of the property.

(b) What are the main objectives of producing draught in a boiler?

Answer: The main objects of producing draught in a boiler are:

1. To provide an adequate supply of air for the fuel combustion.
2. To exhaust the gases of combustion from the combustion chamber.
3. To discharge these gases to the atmosphere through the chimney.

(c) What is the function of safety valve and economizer in a boiler?**Answer: Economizer:**

An economizer is a device used to heat feed water by utilizing the heat in the exhaust flue gases before leaving through the chimney. As the name indicates, the economizer improves the economy of the steam boiler.

Safety Valve

- The safety valve (pressure relief valve) is used in a boiler to relieve the pressure of steam when it is above the working pressure.
- Its function is to discharge a portion of the steam from the boiler automatically when the steam pressure exceeds the normal limit. It is mounted on the top of the shell.
- As per boiler regulation two safety valves are required to be fitted in each boiler

4. (a) Differentiate between allowance, tolerance and clearance.

Answer: Allowance: It is the difference between the basic dimensions of the mating parts.

Tolerance: It is the difference between the upper limit and lower limit of a dimension. In other words, it is the maximum permissible variation in a dimension.

Clearance: Unobstructed space required for occasional removal of parts of equipment. In a piston-and-cylinder mechanism, the space at the end of the cylinder when the piston is at dead-center position toward the end of the cylinder.

(b) Describe any taper turning method used in lathe.

Answer: A taper may be turned by any one of the following methods:

- By setting over the tailstock centre.
- By swiveling the compound rest.
- By a taper turning attachment

Taper Turning by Setting over the Tailstock: The principle of turning taper by this method is to shift the axis of rotation of the workpiece, at an angle to the lathe axis, and feeding the tool parallel to the lathe axis. The angle at which the axis of rotation of the workpiece is shifted is equal to half the angle of the taper. The body of the tailstock is made to slide on its base towards or away from the operator by a set over screw. The amount of set over being limited, this method is suitable for turning small taper on long jobs. The main disadvantage of this method is that the live and dead centres are not equally stressed and the wear is not uniform. Moreover, the lathe carrier being set at an angle, the angular velocity of the work is not constant.

(c) Why tempering is done and how it is done?

Answer: Tempering is a process of reducing the degree of hardness and strength and increasing the toughness. It removes the brittleness from a hardened piece. It is a process that follows the hardening procedure and makes the metal as hard and tough as possible.

Tempering is done by reheating the metal to low or moderate temperature, followed by quenching or by cooling in air. As the metal is heated for tempering, it changes in color. These colors are called temper colors. To know the correct heat, a more accurate method is to watch the pyrometer.

5. (a) What is difference between refrigeration and air conditioning?

Answer:-Air-conditioning is a process that simultaneously conditions air; distributes it combined with the outdoor air to the conditioned space; and at the same time controls and

maintains the required space's temperature, humidity, air movement, air cleanliness, sound level, and pressure differential within predetermined limits for the health and comfort of the occupants, for product processing, or both.

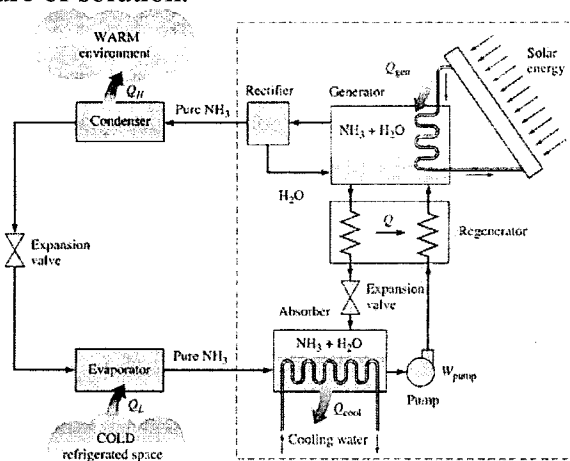
Whereas,

Refrigeration is the cooling effect of the process of extracting heat from a lower temperature heat source, a substance or cooling medium, and transferring it to a higher temperature heat sink, probably atmospheric air and surface water, to maintain the temperature of the heat source below that of the surroundings.

In short, refrigeration: removes heat from a local space air conditioning: conditions air and includes such aspects as indoor air quality.

(b) Discuss the vapor absorption refrigeration system with neat sketch.

Answer: The simple vapor absorption system consists of an absorber, a pump, a generator and a pressure reducing valve to replace the compressor of vapor compression system. The other components of the system are condenser, receiver, expansion valve and evaporator as in the vapor compression system. In this system, the low pressure ammonia vapor leaving the evaporator enters the absorber where it is absorbed by the cold water in the absorber. The water has the ability to absorb large quantities of ammonia vapor and the solution thus formed known as aqua-ammonia. The absorption of ammonia vapor in water lowers the pressure in the absorber which in turn draws more ammonia vapor from the evaporation and thus raises the temperature of solution.



(c) A condenser of a refrigeration system rejects heat at the rate of 120KW while the compressor consumes a power of 30KW. What is the COP of the system?

Solution: Here,

Heat rejection in the condenser,

$$Q_2 = Q_1 + W_R = 120, W_R = 30\text{KW} \therefore Q_1 = 120 - 30 = 90\text{KW}, \text{COP}=?$$

$$\text{We know, } \text{COP} = \frac{Q_1}{W_R} = \frac{90}{30} = 3 \text{ (Ans.)}$$

Bangladesh Chemical Industries Corporation (BCIC)**Post: Assistant Engineer(Mechanical)****Time-10.00AM to 11.30AM****Date: 25.11.2016****Exam Hall: ECE Building, BUET**

Questions Courtesy: Members of ME Job Preparation group (Non-Departmental & Departmental) Special thanks to Halima Tahmina

$60 \times 0.5 = 30$; $10 \times 1 = 10$; $12 \times 5 = 60$;

1. Chairman call _____ meeting tomorrow?

a. Call in b. Call off c. Call for d. call on

Answer: call for

2. Which of the following device can store 500GB data?

a. Floppy Disk b. Hard Disk c. DVD d. VCD

Answer: Hard Disk

3. Who wrote book "A search for identity" a. Major Jalil b. Anirudha Roy

Answer: Major Jalil

4. Which country is located between Indian and Atlantic Ocean?

a. South Africa b. Kenya c. Japan

Answer: a. South Africa

5. India has longest land border with which country? a. Pakistan b. Bangladesh

c. Nepal d. China Answer: Bangladesh

6. What should be percentage of land in a country that has to be forest?

Answer: 25%

7. Who is the designer of komolapur railway station? Answer: Robert Boughey

8. Battle of Water loo was held? Answer: Belgium

9. Musfiquir Rahim Plays 50th test against- Answer: England

10. It was nice _____ you the last day. a) meet b) to met c)meeting Answer: meeting

11. Who is the designer national shaheed minar- a) Hamidur Rahman b) Moinul Islam c) Luit Kan

Answer: Hamidur Rahman

12. Who is the architect of Oporajeo Bangla at DU?

Answer: Syed Abdullah Khalid

13. He has grown up in placid surrounding- what does that mean?

Answer: serene environment

14. Adolescence means-

15. What is the nearest meaning of "commemoration"? Answer: Celebration

16. Which muslim country first declare israel as a country? Answer: Turkey

17. Which is the plural form of "single"? Answer: Singles

18. "Coma" means- Answer: State of deep unconsciousness

19. পরীক্ষা এর সন্ধি বিচ্ছেদ কোনটি? উত্তর: পরি + ঈক্ষা।

20. পদ-প্রকরণ ব্যাকরণের কোন অংশের আলোচ্য বিষয়? ক) রূপতত্ত্বের খ) ধ্বনিতত্ত্বের গ) বাক্যতত্ত্বের ঘ) অর্থতত্ত্বের উত্তর: (ক)

21. ঋজু এর বিপরীত শব্দ? উত্তর: বঙ্কিম

22. নিচের কোন দুটি খাঁটি বাংলা উপসর্গ? ক) অনা, কদ খ) সম, গর গ) কু, নি ঘ) অজ, অভি
উত্তর: ক

23. স্ত্রীলিঙ্গ মিশ্র শব্দটি কোন কোন ভাষার মিশ্রণে গঠিত হয়েছে? উত্তর: ইংরেজী+সংস্কৃত।

24. কোনটি সন্ধির উদ্দেশ্য? ক) শব্দের মিলন খ) বর্ণের মিল গ) ধ্বনিগত মাধুর্য সম্পাদন
ঘ) শব্দগত মাধুর্য সম্পাদন উত্তর: (গ)

25. উপসর্গের কাজ কী? ক) বর্ণ সংস্করণ খ) নতুন শব্দ গঠন গ) ভাবের পার্থক্য নিরূপণ
ঘ) যতি সংস্থাপন উত্তর: (খ)

26. মর্সিয়া শব্দের অর্থ কি? উত্তর: শোকগাথা।

27. কুলির স্ত্রী লিঙ্গ কোনটি? ক) মালিকা খ) মালবিকা গ) মালানী ঘ) মালিনী
বি.দ্র.: প্রশ্নটির অপশনে মালা এর স্ত্রী লিঙ্গের উত্তর দেওয়া আছে। কুলি-কামিন

28. হাজার বছর ধরে উপন্যাসের লেখক কে? উত্তর: জহির রায়হান

29. নিরাকার এর সন্ধি বিচ্ছেদ কি? উত্তর: নিঃ +আকার

30. উলু খাগড়া বাগধরাটির অর্থ কি? নিরীহ প্রজা

বি.দ্র.: অপশনগুলোতে নিরীহ প্রজা ছিল কি না মনে নেই। তবে ব্যক্তিত্বহীন দুর্বল ব্যক্তি ছিল মনে হয়।

31. দেবতার ধন ফিরিয়ে লয়ে যায় কে? দেবতার কোন কারকে কোন বিভক্তি? উত্তর: সম্প্রদানে ষষ্ঠী

32. নিচের কোনটি সঠিক? আমার এ কথাটি সত্য প্রমাণিত হয়েছে।

33. Who is the organizer of Bangla years? Answer: Akbar

34. Which one is correct?

a) A sinking man catches the straw.

b) A drowning man catches a straw.

c) A sinking man catch the straw.

b) A drowning man catch a straw. Answer: b

35. The first barge mounted power plant in Bangladesh is situated on the bank of river?

Answer: Bhairab.

36. Where writable and readable disk are attached together? Answer: Floppy Disk Drive

37. Plural form of single is? Answer: singles

38. Data is related the word- a) Datum b) Number c) Digit Answer: Number

39. 620, 632, 608, 644, 596, in the series which number will come? Answer: 656

40. Father's age was four times of son's age 8 years ago. After 8 years father's age will be two times of son's age. Find father's present age. Answer: 40 yrs.

41. First 100 Km goes with 50 Km/hr. and second 120 Km with 40 Km/hr. Find the average speeds? Answer: 44Km/hr.

42. A man sees 160m train passes a platform by 54 seconds but himself by 30 seconds. Find the length of the train? Answer: 200m

43. A hall is 15 m long and 12 m broad. If the sum of the areas of the floor and the ceiling is equal to the sum of the areas of four walls, the volume of the hall is:

a) 720 b) 900 c) 1200 d) 1800

Answer: c

Explanation:

$$2(15 + 12) \times h = 2(15 \times 12)$$

$$\text{Volume} = 15 \times 12 \times 20 = 1200$$

44. If it takes t numbers of works $1/x$ times, what will be the work for time x? Answer: tx^2

45. 1 Horse Power = W? Answer: 746 W.

46. Which is the right spelling?

a) Quosient b) Quiescent Answer: b

47. "Adolescence" is close to the word – a) complex b) painful

48. To construct a network based on rules is called- Answer: protocol

49. First computer network is made by- ?

50. What is the origin of the word "Lunar"? Answer: Moon

51. নিচের কোনটি ব্যাকরণের আনুষঙ্গিক আলোচ্য বিষয়? উত্তরঃ ছন্দ

52. Ratio of girls and boys in a hostel is 5:3. What is not the possible amount of boys?

Answer: 1350 । তবে যে অপশন (৫+৩=)৮ দ্বারা নিঃশাসে বিভাজ্য হবে না সেটায় উত্তর হবে।

53. I will update you once I remember more (অপশনগুলো মনে নাই।)

54. A wise person do alike a fool will never (এইটাইপের কিছু একটা ছিল..)

56. Sakib used to water in the morning. Here water a)noun b)verb c)adjective d) adverb.

Answer: b) verb

57. May day is the historic_ a) war b) struggle

58. Ctrl+end in excel sheet goes to- Answer: End of the sheet

Departmental

1. For an air compressor intermediate pressure is equal to – $P_i = \sqrt{P_1 P_2}$

2. Why steam traps are used?- **Answer: To drain the condensate**

3. Why baffles are provided in heat exchangers? **Answer: To increase the heat transfer**

4. Quick return mechanism used in which machine? **Answer: Shaper Machine**

5. Why partial journal bearing is used?

6. Which anti friction bearing can't take thrust load? – **Straight Roller Bearing**

7. Load factor is the ratio of- **Average Load/ Maximum Demand**

8. Suction pressure of a pump is – a) negative b) Zero c) Positive

9. Surge tank is used for - Surge tank in a pipe line is used to

a)reduce the loss of head due to friction in pipe

b)make the flow uniform in pipe

c) relieve the pressure due to water hammer

d) for the emergency situation

10. Kaplan turbine is a – **Low pressure High discharge**

11. Efficiency of air standard Otto cycle is 50%. Find out the compression ratio of the engine if the specific heat ratio (C_p/C_v) of the working fluid is considered as 1.50.

Solution: Given, $\eta = 50\% = 0.50$ $\gamma = 1.5$ $r = ?$

We get, $\eta = 1 - \frac{1}{(r)^{\gamma-1}}$

$\Rightarrow 0.5 = 1 - \frac{1}{(r)^{1.5-1}}$

$\Rightarrow 0.5 = \frac{1}{(r)^{0.5}}$

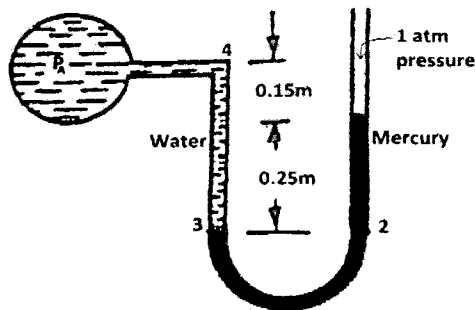
$\Rightarrow r = 4$ **(Answer)**

12. An ice plant using water at 10 °C produce 450×10^3 Kg of ice in 24 hrs. Calculate the capacity of the ice plant in TOR.

Solution: Given, $m = 3000\text{Kg}$; $t = 24 \times 60$ mins; $\Delta\theta = 10 - 0 = 10\text{K}$

$$\begin{aligned}
 \therefore \text{Capacity} &= \frac{ml_f}{24 \times 60} + \frac{ms\Delta\theta}{24 \times 60} \\
 &= \frac{450 \times 10^3 \times 332}{24 \times 60} + \frac{450 \times 10^3 \times 4.2 \times 10}{24 \times 60} \\
 &= 116875 \text{ KJ/min} \\
 &= 556.54 \text{ TOR (Answer)}
 \end{aligned}$$

13. Calculate the pressure P_A .



Solution: At the datum line 3-2, we get,

$$P_A + (\rho gh)_{\text{water}} = P_{\text{atmosphere}} + (\rho gh)_{\text{mercury}}$$

$$\text{or, } P_A + (1000 \times 9.8 \times 0.4)_{\text{water}} = 101325 + (13.6 \times 1000 \times 9.8 \times 0.25)_{\text{mercury}}$$

$$\text{or, } P_A = 134645 - 3920 = 130725 \text{ Pa}$$

$$\therefore P_A = 130.725 \text{ KPa (abs.) (Answer)}$$

14. In a pipe air (1.005 KJ/KgK) is flowing with a velocity of 350 m/s at 100 KPa and 25°C . Calculate the stagnation pressure and temperature.

Solution: For air $k=1.4$

From stagnation Temperature relationship,

$$T_s = T + \frac{V^2}{2C_p} = 298 + \frac{350^2}{2 \times 1.005 \times 1000} = 358.94 \text{ K (Answer)}$$

$$\text{Again, } \frac{P_s}{P} = \left(\frac{T_s}{T}\right)^{\frac{k}{k-1}}$$

$$\Rightarrow P_s = P \times \left(\frac{T_s}{T}\right)^{\frac{k}{k-1}}$$

$$\Rightarrow P_s = 100 \times \left(\frac{358.94}{298}\right)^{\frac{1.4}{1.4-1}} = 191.8 \text{ KPa (Answer)}$$

15. A Carnot engine receives 500 KJ of heat from a high temperature source (625°C) and rejects heat to a low temperature sink (30°C). What will be the efficiency of Carnot heat engine?

Solution: Given that, $T_1 = 625^\circ \text{C} = 625 + 273 = 898 \text{ K}$ & $T_2 = 30^\circ \text{C} = 30 + 273 = 303 \text{ K}$.

$$\text{We get, } \eta = \frac{T_1 - T_2}{T_1} = \frac{898 - 303}{898} = 0.6626 = 66.26 \% \text{ (Answer)}$$

16. A pump delivers 10 litres/sec of water at a pressure difference of 2 MPa . Calculate the water horse power.

Solution: We get,

$$P = h\rho gQ = PQ = 10 \times 10^{-3} \times 2 \times 1000 = 20 \text{ KW} = 26.81 \text{ hp (Answer)}$$

17. A steel shaft has a solid cross section and transmits power at 100rpm. Take $E = 200$ GPa, $G = 84$ GPa, length = 1200mm, diameter = 15mm, if the torque developed is 9550 N-mm, calculate the power transmitted and maximum shear stress developed.

Solution:

Here, $N = 100 \text{ rpm}$; $\omega = \frac{2\pi N}{60} = \frac{2\pi \times 100}{60} = 10.47 \text{ rad/sec}$; $T = 9550 \text{ Nmm} = 9.55 \text{ Nm}$

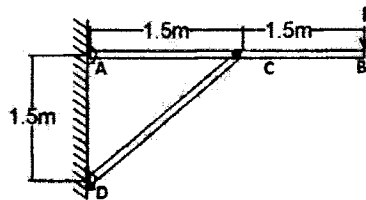
We get,

$$\begin{aligned} P &= T \times \omega \\ &= 9.55 \times 10.47 \\ &= 100 \text{ Watts (Answer)} \end{aligned}$$

Again,

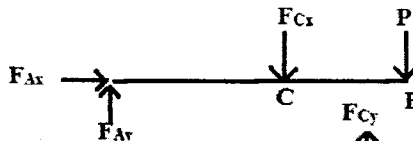
$$\begin{aligned} \tau &= \frac{16T}{\pi d^3} \\ \Rightarrow \tau &= \frac{16 \times 9.55}{\pi \times 0.015^3} \\ &= 14.41 \text{ MPa (Ans.)} \end{aligned}$$

18. Draw free body diagram of member ACB and CD. Considering the system in static equilibrium, find out the force P if the compressive force in member CD is 2KN.



Solution:

FBD of ACB:

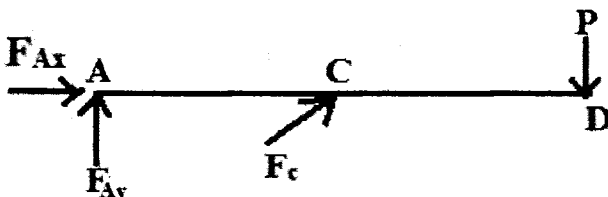


FBD of CD:



We get,

$$\begin{aligned} \tan \angle ACB &= \frac{1.5}{1.5} = 1 \\ \therefore \angle ACB &= 45^\circ \end{aligned}$$

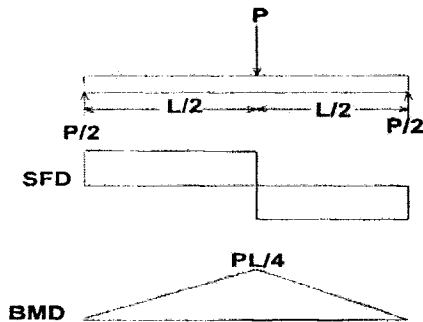


$$\curvearrowright + \sum M_A = 0$$

$$\Rightarrow 1.5 \times F_c \sin 45^\circ = P \times 3$$

$$\Rightarrow P = \frac{1.5 \times 2 \times \sin 45^\circ}{3} = 0.707 \text{ kN} = 707 \text{ N (Answer)}$$

19. A concentrated load P is applied at the midspan of a simply supported beam of length L . Draw the bending moment and shear force diagram and the point on the beam which will be most critically stressed.



At the point at which load P acts, the bending moment at that point is maximum. At this point the beam will be most critically stressed.

20. Water is heated from 35°C to 75°C by oil in a counter flow double pipe heat exchanger. The oil enters the heat exchanger at 111°C and leave at 75°C . Calculate LMTD in this situation.

Solution:

Here, $T_{\text{cin}} = 35^\circ\text{C}$ and $T_{\text{cout}} = 75^\circ\text{C}$, $T_{\text{hin}} = 111^\circ\text{C}$ and $T_{\text{hout}} = 75^\circ\text{C}$.

$$\Delta T_1 = T_{\text{hin}} - T_{\text{cout}} = 111 - 75 = 36$$

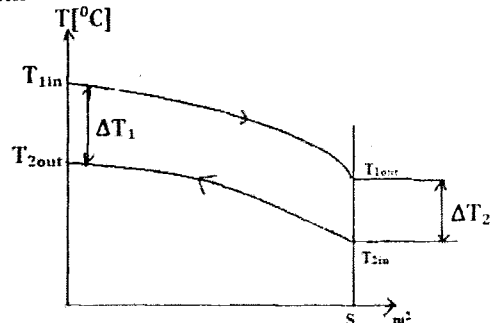
$$\text{and } \Delta T_2 = T_{\text{hout}} - T_{\text{cin}} = 75 - 35 = 40$$

$$\therefore \text{LMTD} = \frac{\Delta T_2 - \Delta T_1}{\ln \frac{\Delta T_2}{\Delta T_1}}$$

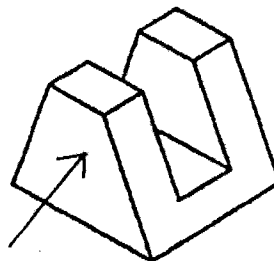
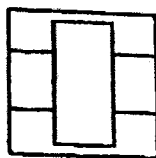
$$= \frac{40 - 36}{\ln \frac{40}{36}}$$

$$\therefore \text{LMTD} = 37.97$$

$$\approx 38^\circ\text{C} \text{ or } 38 \text{ K (Answer)}$$



21. Draw TOP VIEW, LEFT and SIDE VIEW and FRONT VIEW.



22. A thin wall pressure vessel is 50 mm mean radius with a wall 2.5 mm thick. Calculate the maximum allowable internal pressure if the stress in the wall must not exceed 150MPa.

Solution: The solution must be based on the circumferential stress since this is the largest.

$$\sigma_c = PD/2t = 150 \text{ MPa}$$

$$\Rightarrow P = 150 \text{ MPa} \times 2t/D = 150 \times 2 \times 0.0025/0.1$$

$$\therefore P = 7.5 \text{ MPa (Answer)}$$

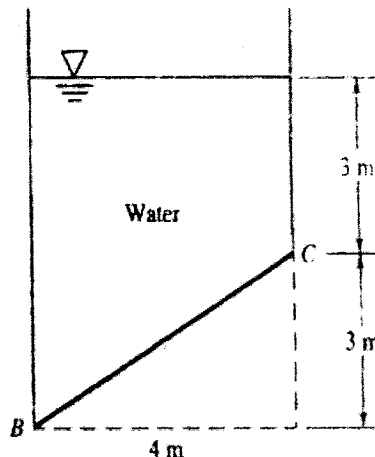
Eastern Refinery Limited (ERL)
Post: Probationary Engineer(Mechanical)
Time 10.00AM to 11.30AM
Date:20.01.2017
Exam Hall: ECE Building, BUET

Non-Departmental

1. Which country's citizen discovered Europe to India road? **Portuguese**
 2. Land of the Midnight Sun- **Norway**
 3. Rain water fall drop – **surface tension**
 4. BNS Nabajatra- **Sub Marine**
 5. Which test refers white blood cell?- **WBC**
 6. What is the unit of length used to measure distances to objects outside our Solar System? - **Light year**
 7. what is the unit of measuring ozone layer thickness ? **Dobson Unit.**
 8. Which gas is not responsible for climate change/global warming? ---- **Nitrogen** (Question + answer not sure. May be similar of this..)
 9. In which layer the increase of temperature with altitude is a result of the absorption of the Sun's ultraviolet radiation by ozone? --**stratosphere**
 10. The indigenous people of North America- **Red Indians**
 11. Which country uses Bangla as 2nd mother language?-- **Seara Leone.**
 - ১) রাত্রির সমার্থক শব্দ নয় কোনটি? -- **বারিদ**
 - ২) চাঁদের হাট বাগধারার অর্থ কি?-- **আনন্দের প্রাচুর্য**
 - ৩) অম্বু এর সমার্থক শব্দ কোনটি-- **সলিল**
 - ৪) মুগয়া অর্থ কি?-- **হরিণ শিকার**
 - ৫) গৃহী এর বিপরীত শব্দ -- **সন্ন্যাসী**
 - ৬) প্রসারণ এর বিপরীত শব্দ কি?-- **আকুঞ্জন**
 - ৭) মানব এর প্রকৃতি প্রত্যয় কি?-- **মনু+ষ্ণ**
 - ৮) সমার্থক বাগধারা নয় কোনটি?-- **আদায় কাচকলায়**, দা-কুমড়া অহি নকুল বাদে যেটা ছিল
 - ৯) করুণাময় তুমি, করুণাময় কোন বিশেষণ?-- **সর্বনামের বিশেষণ**
 - ১০) তিনি চট্টগ্রাম থেকে ঢাকা এসেছে। কোন কারক?--**অপাদান।**
 - ১১) একই স্বরের পুনরাবৃত্তি দূর করার জন্য মাঝখানে কোন স্বরধনি যুক্ত করাকে কি বলে?-- **অসমীকরণ**
 - ১২) যে সকল বিদেশি শব্দের কোন সমার্থক শব্দ নেই তাকে কি বলা হয়?--**পারিভাষিক শব্দ**
- বাকি গুলো মনে নাই

Departmental MCQ

1. High head developed
2. Secondary air flow in gas turbine
3. Hoop stress ratio
4. Gas turbine works on which cycle
5. Overhanging rod
6. Computer related
7. Time period relation with damping coefficient
8. Not Desirable refrigerant properties
9. for supersonic flow nozzle velocity,
10. When Engine efficiency is maximum?--1. Rich Air fuel mixture. 2. Lean Air fuel mixture. 3. Homogeneous 4. Heterogeneous
11. The tank is 2 m wide into the paper. Neglecting atmospheric pressure, find the resultant hydro static force on panel BC.

**Solution:**

We get, $BC = \sqrt{4^2 + 3^2} = 5\text{m}$

The resultant force F , may be found by simply applying the hydrostatic relation,

$$F = h\rho g A = \left(3 + \frac{3}{2}\right) \times 1000 \times 9.81 \times (5 \times 2)$$

$$= 441450\text{N} = 441.45\text{KN (Answer)}$$

12. A pitot static tube is used to measure the velocity of water in a pipe of diameter 10cm. The static pressure is 2KPa. Calculate the velocity and flow rate of the pipe flow.

Solution: We get from Bernoulli equation,

$$\frac{P}{\rho g} = \frac{v^2}{2g}$$

$$\Rightarrow P = \frac{1}{2} \rho v^2$$

$$\Rightarrow v = \sqrt{\frac{2P}{\rho}} = \sqrt{\frac{2 \times 2000}{1000}} = 2.0\text{m/s (Answer)}$$

Again, $Q = Av = \frac{\pi}{4} D^2 \times v = \frac{\pi}{4} 0.1^2 \times 2 = 0.016 \text{ m}^3 / \text{sec}$ (Answer)

Another solution: $P = h\rho g$; $v = \sqrt{2gh}$

13. In a boiler plant mass installation is 8 ton/hr. If the enthalpy of steam is 2676 kJ/kg and feed water is 420 KJ/Kg, find the boiler power in KW and HP.

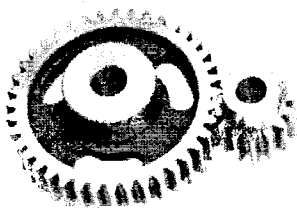
Solution: Given, $h = 2676 \text{ KJ/Kg}$; $h_f = 420 \text{ KJ/Kg}$; $m = 8 \text{ ton/hr}$;

$$\text{Boiler Power} = m(h - h_f) = \frac{8 \times 1000}{3600} \times (2676 - 420)$$

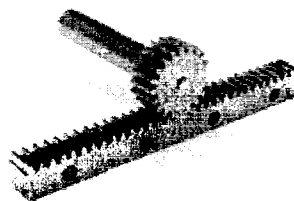
$$= 5.013 \text{ KW (Answer)}$$

$$= 0.511 \text{ HP [1 boiler Horsepower} = 9.81 \text{ KW]} \text{ (Answer)}$$

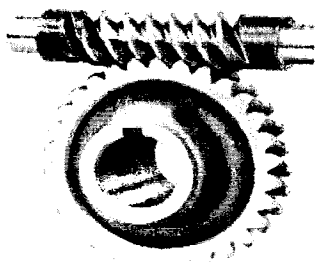
14. Write the name of the following machines (/elements).



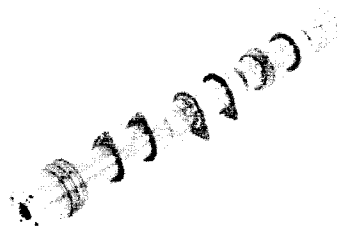
Spur Gear



Rack and Pinion



Worm Gear



Cam Shaft



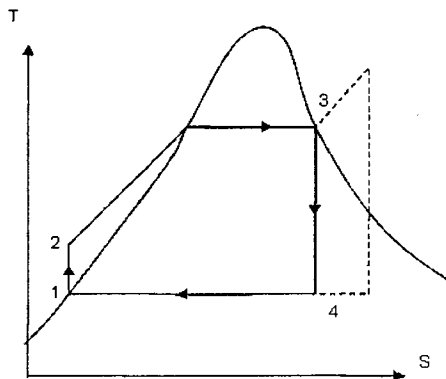
Leaf Spring

15. Write the purpose of following instruments.

Pyrometer	High Temperature measurement
Dynamometer	An instrument that measures the power output of an engine.
Rota meter	A rotameter is a device that measures the flow rate of fluid in a closed tube.

Hydrometer	A hydrometer or aerometer is an instrument that measures the specific gravity (relative density) of liquids.
Odometer	An instrument for measuring the distance traveled by a vehicle.

16. Draw the vapor Rankine Cycle on temperature and entropy (TS) plane. Show thermodynamics processes with the corresponding equipment.



1-2: Reversible adiabatic pumping process in the pump,

2-3: Constant-pressure transfer of heat in the boiler,

3-4: Reversible adiabatic expansion in the turbine (or other prime mover such as a steam engine),

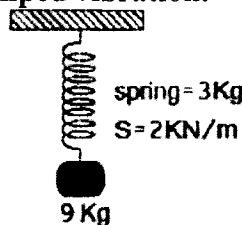
4-1: Constant-pressure transfer of heat in the condenser.

17. In a thermodynamics cycle mass of working substance is 0.83kg, initial pressure is 0.7 MPa, initial volume is 0.823 m³ and after expansion volume becomes 1.425 m³. Find (i) Workdone for constant pressure process. (ii) Work done for isothermal process.

Solution: (i) $W = P (V_2 - V_1) = 0.7 \times 10^6 \times (1.425 - 0.823) = 421.4 \text{ kJ}$ (Answer)

(ii) $W = 2.3 P_1 V_1 \log \frac{V_2}{V_1} = 2.3 \times 0.7 \times 10^6 \times 0.823 \times \log \left(\frac{1.425}{0.823} \right) = 316.26 \text{ kJ}$ (Answer)

18. Find the frequency for free damped vibration.



Solution:

Given, mass of load, $m_w = 9 \text{ Kg}$; mass of spring, $m_s = 3 \text{ Kg}$; $s = 2 \text{ kN/m} = 2000 \text{ N/m}$; $f_n = ?$

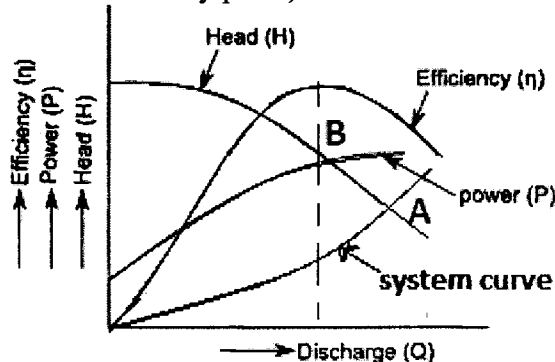
We get,

$$f_n = \frac{1}{2\pi} \sqrt{\frac{s}{m_w + \frac{m_s}{3}}} = \frac{1}{2\pi} \sqrt{\frac{2000}{9 + \frac{3}{3}}} = 2.25 \text{ Hz (Answer)}$$

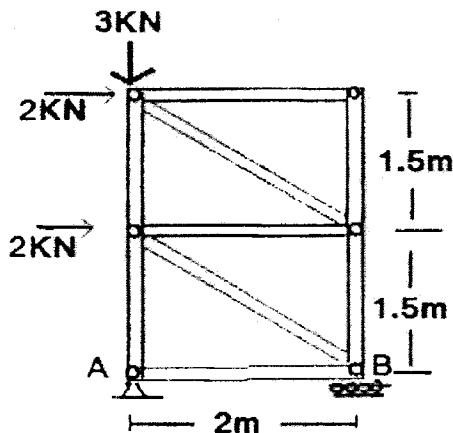
19. Draw the typical performance curves of centrifugal pump showing the design/duty point.

Answer:

Here, Point A is the operating point (where system curve and head curve meets; system curve is a function of elevation or static head including major and minor losses). Point B is the design point (consider at best efficiency point).



20. Find the reaction at point B.



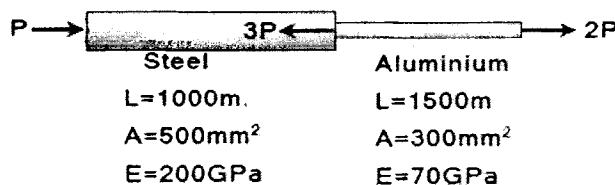
Solution:

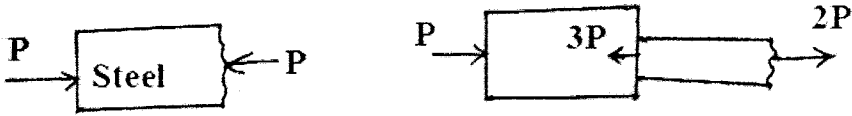
Taking moment at A, $\sum M_A = 0$

$$\text{or, } 2 \times 3 + 2 \times 1.5 - B_y \times 2 = 0$$

$$\text{or, } B_y = \frac{9}{2} = 4.5 \text{ kN (Answer)}$$

21. Find the maximum load P that will not exceed overall deflection 3mm.



Solution:

$$\delta_{st} = \frac{PL}{AE} [P\text{-Compression}]$$

$$= \frac{P \times 1000}{500 \times 10^{-6} \times 200 \times 10^9} = P \times 10^{-5}$$

$$\delta_{Al} = \frac{2PL}{AE} [P\text{-Tension}]$$

$$= \frac{2P \times 1500}{300 \times 10^{-6} \times 70 \times 10^9} = 1.43P \times 10^{-4}$$

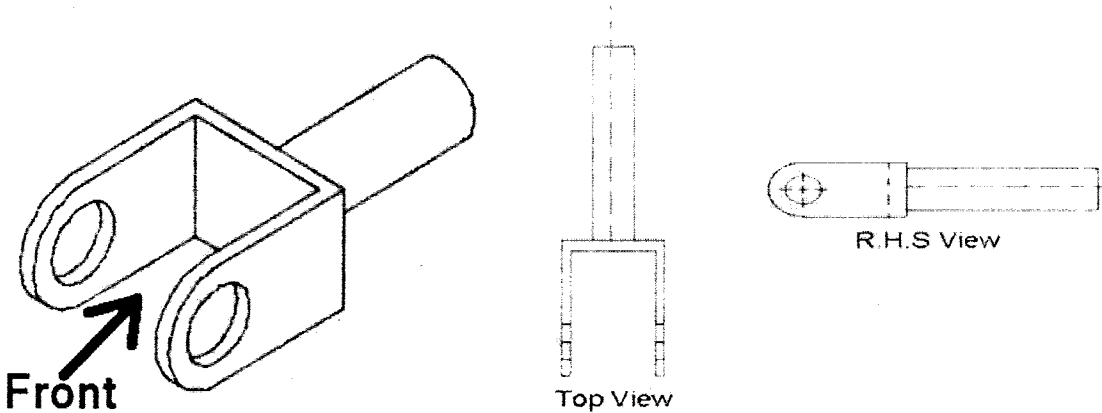
We get,

$$\delta_{Al} - \delta_{st} = 3 \times 10^{-3}$$

$$\text{or, } 1.43P \times 10^{-4} - P \times 10^{-5} = 3 \times 10^{-3}$$

$$\text{or, } P \times 1.33 \times 10^{-4} = 3 \times 10^{-3}$$

$$\therefore P = 22.55 \text{ N (Answer)}$$

22. Draw the TOP view and RHS view.**Bangladesh Export Processing Zone Authority (BEPZA)****Post: Assistant Engineer(Mechanical)****Time-10.00AM to 12.00PM****Date: 30.12.2016****Exam Hall: BEPZA Public S&C, Saver EPZ****Non-departmental questions**

1. (i) শেষের কবিতা কি ধরনের রচনা? উঃ - উপন্যাস
- (ii) পদ্মা-মেঘনা-যমুনা কার লেখা? উঃ- আবু জাফর শামসুদ্দীন
- (iii) যা সহজে অতিক্রম করা যায় না-এক কথায় প্রকাশ। উঃ -দুরতিক্রম্য
- (iv) “অত্যন্ত” এর সন্ধি বিচ্ছেদ কি? উঃ- অতি+অন্ত

(v) “শিশু” কোন লিঙ্গ? উ:- উভলিঙ্গ।

(vi) “মরমি কবি” বলা হয় কাকে? উ:- হাসন রাজা (তথ্য সূত্রঃ বাংলাপিডিয়া)

(vii) বাক্যটির শুদ্ধরূপ কি হবে- আপনি স্বপরিবারবর্গসহ আমন্ত্রিত? উ:- আপনি স্বপরিবারে আমন্ত্রিত

(viii) “স্বশ্রদ্ধা” শব্দটির সঠিক বানান কোনটি? উ:- সশ্রদ্ধা

(ix) বাংলায় প্রথম স্বার্থক মহাকাব্য কোনটি? উ:- মেঘনাদবধ কাব্য

2. (i) What is the plural form of memorandum? Answer:- memoranda

(ii) What is the antonym of Apex? Answer:- Bottom

(iii) Who is the writer of war and peace? Answer:- Leo Tolstoy

(iv) Write the passive of 'I know where he lives' Answer:- It is known to me that where he lives

(v) Which type of sentence it is- “Do or die”? Answer:- Compound sentence

3. Elaborate these- BEPZA, CETP, UNHCR, VIRUS, HTTP.

Answer: BEPZA- Bangladesh Export Processing Zone Authority

CETP- Common Effluent Treatment Plant / Certified Employee Training Program/
Cholesteryl Ester Transfer Protein

UNHCR- United Nations High Commissioner for Refugees

VIRUS- Vital Information Resources Under Siege

HTTP- Hypertext Transfer Protocol

4. (i) How many EPZ's under BEPZA? Answer:- 8 (Website of EPZ shows that)

(ii) Who is the architect of Kamapur Railway station? Answer: Robert Boughey

(iii) How many districts has land border with India? Answer:-30

(iv) Which is the largest (by area) district of Bangladesh? Answer:- Rangamati

(v) Which is the largest island of Bangladesh? Answer:- Bhola

5. (i) Which was the latest Environmental summit? Answer:-

(ii) How many objectives of SDG? Answer:- 17

(iii) How difference of time between Greenwich and Bangladesh? Answer: +6 hours

(iv) Which is the largest organ of human body? Answer:- Skin

(v) What is the meaning of “Diamond Cuts Diamond”? Answer:- মানিকে মানিক চেনে

6. Two train of 200m and 300m moves at a velocity of 40Km/hr and 30Km/hr in parallel. When they will cross each other?

Answer:

[Length of The Train 1 + Length of the Train 2](m) = [Speed of the Train1 - Speed of the Train 2] (m/s) × Time taken to cross (s)

7. (i) If a:b= 4:7 and b:c=5:6 then find a:b:c? Answer: 20:35:42

(ii) If $x/a-b=y/b-c=z/c-a$ then $x+y+z=?$ Answer: 0

(iii) If $\sqrt[3]{x}=4$, then $\sqrt{x}=?$ Answer: 8

(iv) Summations of age of father and his son is 74. Age ratio before 10 years is 7:2. Find ratio of age after 10 years. Answer: 31:16

(v) 8,11,17,29,53,___? Answer: 101

8. Translate at English:

(i) ভূমি কতক্ষন আমার জন্য অপেক্ষায় আছে?

(ii) বাংলাদেশের জনগন শান্তিপূর্ণ সহবস্থানে বিশ্বাসী।

Departmental questions

9. What is modulus of elasticity & modulus of Rigidity? Which one is greater? Draw a typical stress strain diagram showing Elastic limit, proportional limit, and Yield point, ultimate strength & breaking strength.

Answer: Modulus of elasticity: Hook's law states that when a material is within elastic limit, the stress is directly proportional to strain.

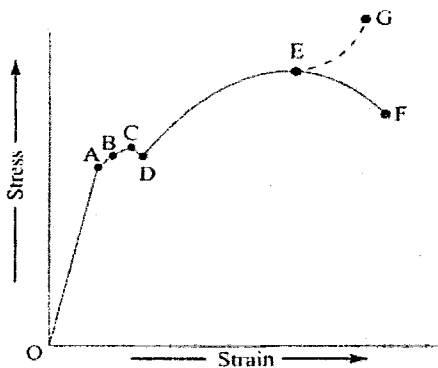
$$\text{i.e., } \sigma \propto \epsilon; \sigma = E\epsilon \therefore E = \sigma/\epsilon$$

Where, E is a constant of proportionality and known as Young's Modulus or modulus of elasticity.

Modulus of rigidity or shear modulus: It is found experimentally that within elastic limit shear stress is directly proportional to shear strain. Mathematically, $\tau \propto \phi$; or, $\tau = C \phi$

Where, τ = shear stress; ϕ = shear strain and C = constant of proportionality, known as Modulus of rigidity or shear modulus. It also denoted by N or G.

For most materials, the modulus of elasticity is larger than the modulus of rigidity.



- A. Proportional limit
- B. Elastic limit
- C. Upper yield point
- D. lower yield point
- E. Ultimate stress/strength
- F. Breaking stress/strength
- G. Actual Rupture Strength

11. Write down second law of thermodynamics.

Answer: According to Kelvin-Planck- "It is impossible to construct an engine working in a cyclic process whose sole purpose is to convert heat energy into an equivalent amount of work.

Clausius Statement: It is impossible for a self-acting machine working in a cyclic process to transfer heat from a body at a lower temperature to a body at a higher temperature without the aid of an external agency.

11. What is cooling tower? Draw a schematic diagram of a cooling tower.

Answer: A cooling tower is a heat rejection device, which extracts waste heat to the atmosphere through the cooling of a water stream to a lower temperature.

(A cooling tower is a specialized heat exchanger in which air and water are brought into direct contact with each other in order to reduce the water's temperature. As this occurs, a small volume of water is evaporated, reducing the temperature of the water being circulated through the tower).

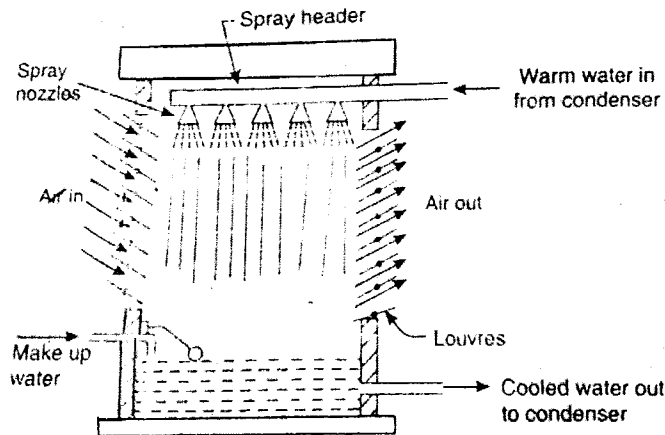


Fig. Natural Draft Cooling Tower

12. What are the Difference between fired tube & water tube boiler? Mention boiler mountings & accessories.

Water Tube Boiler	Fire Tube Boiler
<ol style="list-style-type: none"> 1. The water circulates inside the tubes which are surrounded by hot gases from the furnace. 2. It generates steam at a highest pressure upto 165bar. 3. The rate of generation of steam is high i.e. upto 450 tonnes per hour. 4. For a given power, the floor area required for the generation steam is less, i.e. about 5 m² per tonne per hour of steam generation. 5. Overall efficiency will economizer is upto 90%. 6. It can be transported and erected easily as its various parts can be separated. 7. It is preferred for widely fluctuating loads 8. The direction of water circulation is well defined. 9. The operating cost is very high. 10. The bursting changes are more. 	<ol style="list-style-type: none"> 1. The hot gases from the furnace pass through the tubes which are surrounded by water. 2. It can generate steam only upto 24.5 bar. 3. The rate of generation of steam is high i.e. upto 9 tonnes per hour. 4. For a given power, the floor area required for the generation steam is less, i.e. about 8 m² per tonne per hour of steam generation. 5. Overall efficiency will economizer is upto 75%. 6. The transportation and erection is difficult. 7. It can also cope reasonably with sudden increase in load but for a shorter period. 8. The water does not circulate in a definite direction. 9. The operating cost is less. 10. The bursting changes are less.

Boiler Mountings:

Examples: Water Level Indicator, Pressure gauge, Safety valves, Steam stop valve, Blow off cock, Fusible plug, Feed Check valve

Boiler Accessories: Boiler accessories are- Superheater, Economizer, and Air Preheater.

12. Draw performance curve of a centrifugal pump. How can you identify petrol engine and diesel engines?

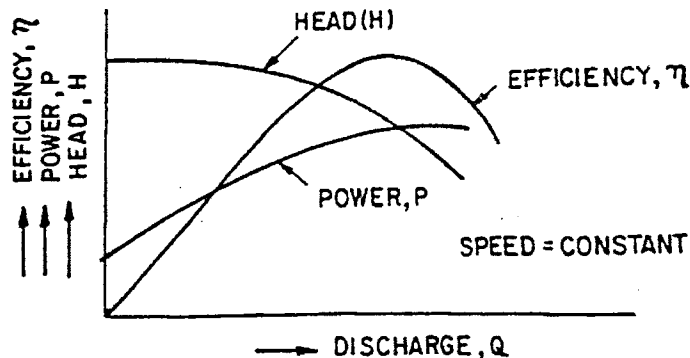


Fig. Operating characteristic curves of a pump.

Diesel engines are compression ignition and petrol engines are spark ignited one. If there is a spark plug its petrol engine or else it would be diesel engine. The presence of fins in the engine compartment also differentiates them apart as Diesel engines have and petrol does not.

11. What are the differences between Gas turbine & I.C. Engine.

	I.C. Engines	Gas Turbines
1.	Ignition and lubrication systems are complicated as compared to gas turbines.	Ignition and lubrication systems are simpler as compared to IC engines.
2.	Weight per HP developed is greater.	Weight per HP developed is lesser.
3.	Exhaust gas pollution is more.	Exhaust gas pollution is comparatively less polluting since excess air is used for combustion.
4.	Thermal efficiency is higher compared to simple gas turbine.	Thermal efficiency is lesser than I.C. engine for simple turbine cycle.
5.	Fuel cost comparatively costlier fuel required.	Fuel cost comparatively cheaper fuel can be used.
6.	Work developed per kg of air is lesser.	Work developed per kg of air is more.
7.	Mechanical efficiency is lower than gas turbine.	Mechanical efficiency is higher than IC engine.
8.	It produces lesser exhaust gases.	It produces exhaust gases five times greater than IC engines.
9.	Requirement of flywheel is a must.	Requirement of flywheel is not required.

10.	IC engine can't be driven at higher speeds.	Gas turbine can be driven at higher speeds
11.	Starting is easier.	Starting is difficult.
12.	Fuel control is comparatively easier.	Fuel control is comparatively difficult due to wide operating speeds.

14. Write short notes on-

(i) Tonne of refrigeration: A tonne of refrigeration is defined as the amount of refrigeration effect produced by the uniform melting of one tonne (1000 kg) of ice formed and at 0 degree Celsius in 24 hours.

In actual practice one tonne of refrigeration is taken as equivalent to 210 KJ/min or 3.5 KW

(ii) Co-efficient of performance (COP):

The coefficient of performance is the ratio of heat extracted in the refrigerator to the work done on the refrigerant.

Theoretically $COP = Q/W$

Q = Amount of heat extracted in the refrigerator (or the amount of refrigeration produced or the capacity of a refrigerator)

W = Amount of work done

(iii) Fouling Factor: During operation of the heat and mass carrying, tube surface gets covered by deposits of ash, soot, dirt and scale etc. This phenomenon of rust formation and deposition of fluid impurities is called fouling. It is difficult to ascertain the thickness and thermal conductivity of scale deposits, the effect of scale on heat flow is considered by specifying an equivalent scale heat transfer coefficient h_s . The reciprocal of heat transfer coefficient h_s is called the fouling factor R_f .

$$R_f = \frac{1}{h_s} = \frac{1}{U_{\text{dirt}}} - \frac{1}{U_{\text{clean}}}$$

(iv) Nuclear Energy:

A small amount of radioactive substance (U_{235}) can produce a lot of energy through the process of nuclear fission. For example, one ton of uranium can provide energy which is much higher than three million tons of coal or 12 million barrels of oil. In order to obtain nuclear energy, nuclear reactors are required. There are around 300 nuclear reactors all over the world.

15. An engine absorbs 1000J heat at 600K temperature & rejects heat 600J at 300k temperature. Determine efficiency and also the maximum possible efficiency.

Solution:

$$\eta = \frac{Q_1 - Q_2}{Q_1} = \eta = \frac{1000 - 600}{1000} = 40\% \text{ (Answer)}$$

$$\text{Maximum Possible Efficiency: } \eta = \frac{T_1 - T_2}{T_1} = \eta = \frac{600 - 300}{600} = 50\% \text{ (Answer)}$$

16. A pressure Gauge measures 25 bars and atmospheric pressure is 1.03 bars and the value of g is 9.8m/s². Determine absolute pressure.

$$P_{\text{abs}} = P_{\text{Gauge}} + P_{\text{atm}} = 25 + 1.03 = 26.03 \text{ bar (Answer)}$$

17. Write the chemical reaction of feed water in a power plant.

There are many processes for feed water treatment. Please read any book. Here from G.R. Nagpal's Book-

Chemical Treatment: (i) Internal Treatment: $\text{CaCO}_3 + 2\text{Na}_3\text{PO}_4 \rightarrow \text{Ca}_3(\text{PO})_2 \downarrow + \text{Na}_2\text{CO}_3$

(ii) External Treatment: (a) Lime Soda Treatment: $\text{Ca}(\text{HCO}_3)_2 + \text{Ca}(\text{OH})_2 \rightarrow 2\text{CaCO}_3 \downarrow + 2\text{H}_2\text{O}$

$\text{MgSO}_4 + \text{Na}_2\text{CO}_3 \rightarrow \text{MgCO}_3 \downarrow + \text{Na}_2\text{SO}_4$

(b) Ion exchange process: $\text{CaSO}_4 + \text{NaZ} \rightarrow \text{Na}_2\text{SO}_4 + \text{CaZ}$

$\text{CaZ} + 2\text{NaCl} \rightarrow \text{Na}_2\text{Z} + \text{CaCl}_2$

18. A jet of vena contracta has a diameter 40mm and the orifice diameter is 32mm. Find co-efficient of contraction.

Solution: $C_c = \frac{A_1}{A_2} = \frac{\frac{\pi}{4} \times 40^2}{\frac{\pi}{4} \times 32^2} = 1.56 \text{ (Answer)}$

Bangladesh Gas Field Company Limited (BGFCL)

Post: Assistant Engineer(Mechanical)

Time-10.00AM to 11.30AM

Date: 10.03.2017

Exam Hall: ECE Building, BUET

1. An air tank is sealed with interior pressure of 130kPa. If it is placed in a reservoir where pressure is 100kPa and temperature is 23°C. Find the gas jet velocity when there is a leak in the tank.

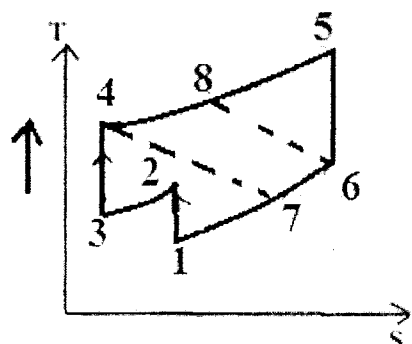
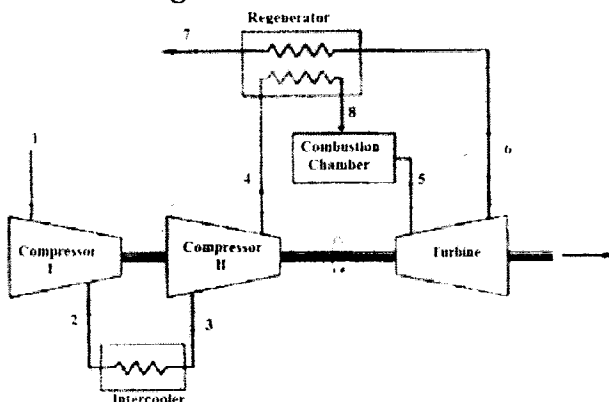
Solution: Given, $P_1 = 130\text{kPa}$, $P_2 = 100\text{kPa}$, $T = 23^\circ\text{C} = 296\text{K}$

We get, $\rho = \frac{P}{RT} = \frac{100 \times 10^3}{287 \times 296} = 1.177 \text{ kg/m}^3$

$\therefore V = \sqrt{2gh} = \sqrt{2g \times \frac{\Delta P}{\rho g}} = \sqrt{\frac{2 \times 30 \times 10^3}{1.177}} = 225.78 \text{ ms}^{-1} \text{ (Answer)}$

N.B.:- It is a possible solution; it may be wrong or may not be.

2. Draw schematic diagram of gas turbine plant with regeneration and intercooling with T-S diagram.



3. A pipe of nominal diameter 500 and 12 mm thickness flows $1 \text{ Mm}^3/\text{day}$ is connected with an air tank of 1 atm and temp. 15°C . when air flows at pressure 100 atm and temperature 25°C with a viscosity 0.000012 Poise, then find the Reynolds number.

Solution: $D_N = 500 \text{ mm}$

Let, $D_N = D_0$ [as D_N is more than 1 in]

$$k = 0.00012 \text{ Poise} = 0.000012 \text{ Ns/m}^2$$

$$\therefore Q = 1 \text{ Mm}^3/\text{day} = 1 \times 10^6 \text{ m}^3/\text{day}$$

$$\therefore D_i = 500 - (2 \times 12) = 476 \text{ mm}$$

$$Q = AV \Rightarrow V = \frac{Q}{A} = \frac{1 \times 10^6}{24 \times 3600 \times \frac{\pi}{4} \times D_i^2} = \frac{1 \times 10^6 \times 4}{24 \times 3600 \times \pi \times (0.476)^2}$$

$$\therefore V = 65.04 \text{ ms}^{-1}$$

$$P = \rho RT \Rightarrow \rho = \frac{P}{RT} = \frac{100 \times 101325}{287 \times 298} = 118.5 \text{ kg/m}^3$$

$$\therefore Re_N = \frac{\rho V D_i}{\mu} = \frac{118.5 \times 65.04 \times 0.476}{0.000012} = 305.65 \times 10^6 \text{ (Answer)}$$

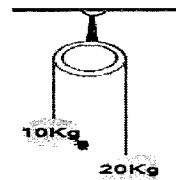
4. Determine the tension of each of rings where the string is frictionless.

Solution:

We get,

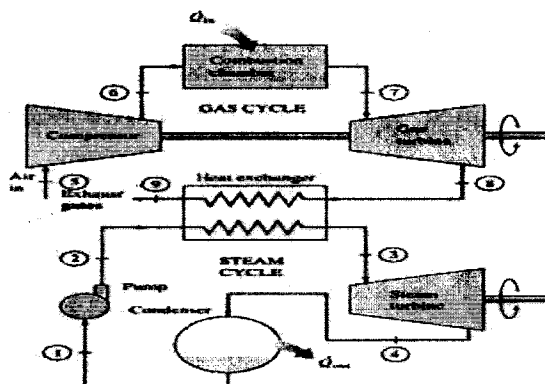
$$T = \frac{2m_1 m_2}{m_1 + m_2} g = \frac{2 \times 10 \times 20}{30} \times 9.81 = 130.8 \text{ N}$$

As the string is frictionless so tension in both cables are same and tension = 130.8 N (Answer)



5. Draw the schematic diagram of combined GT-ST cycle.

Answer:



6. Temperature of inside wall is 80°C and outside wall is 30°C . If the wall is 1m wide, length of the wall is 1.5m and thickness is 6mm. Find the heat flow rate and thermal resistance where $k = 0.4 \text{ W/mK}$.

$$Re = \frac{\rho V D}{\mu}$$

Solution:

$$Q = -kA \frac{dT}{dx} = -0.4 \times 1 \times 1.5 \frac{(30-80)}{0.006}$$

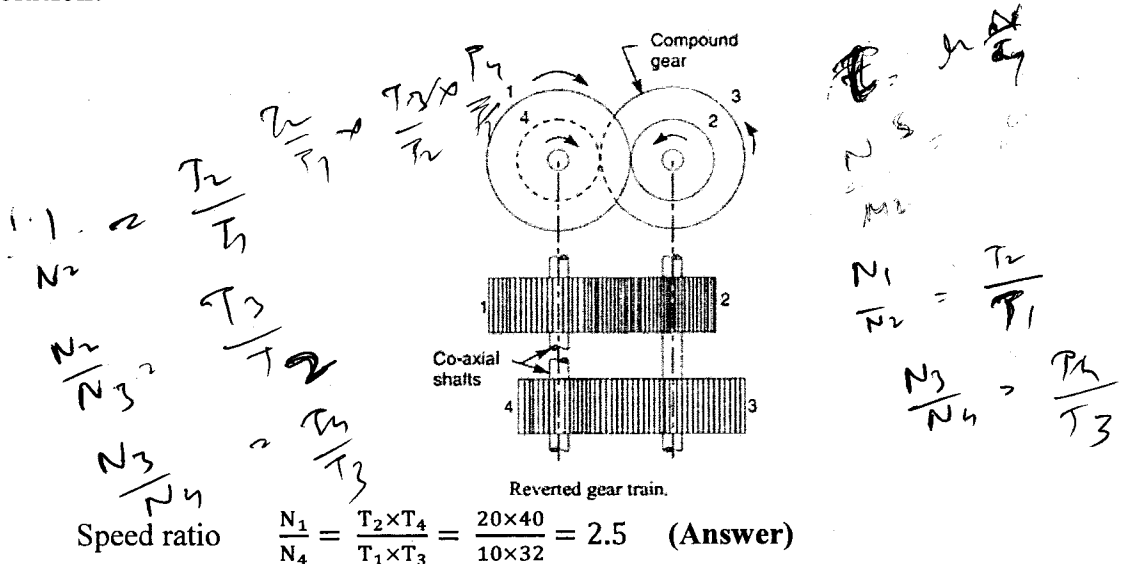
$$\therefore \text{Heat flow rate, } Q = 5000 \text{ J/s (Answer)}$$

$$\text{Thermal resistance, } R_{th} = \frac{x}{kA} = \frac{0.006}{0.4 \times 1 \times 15} \frac{\text{m} \times \text{mk}}{\text{W} \times \text{m}^2}$$

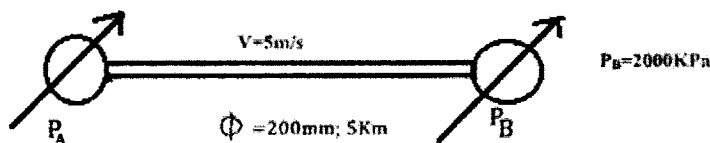
$$\therefore R_{th} = 0.01 \text{ k/W (Answer)}$$

7. A reverted gear shown in figure. Find the speed ratio. Number of teeth are $T_1 = 10$, $T_2 = 20$, $T_3 = 32$ and $T_4 = 40$;

Solution:



8. Find the pressure at pressure gauge A. Take friction factor is 0.01 and water density 1000 kg/m^3 .



Solution:

$$\frac{P_A}{\rho g} + \frac{V_A^2}{2g} + z_A = \frac{P_B}{\rho g} + \frac{V_B^2}{2g} + z_B + h_f$$

$$\Rightarrow P_A = P_B + \rho g \times \frac{fLV^2}{2gd}$$

$$= 2000 \times 10^3 + 1000 \times \frac{0.01 \times 5000 \times 5^2}{2 \times 0.2}$$

$$\therefore P_A = 5125 \text{ KPa (Answer)}$$

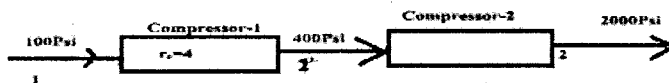
9. Thermal expansion related math.

$$\sigma = \alpha E \Delta T$$

10. Pressure Vessel (Allowable internal pressure).

11. In a series connected compressor inlet pressure is 1000 kPa and discharge pressure is 2000 kPa . How many compressor will need if the compression ratio between 4 to 5.

Solution:



$$r_{c_{1-2'}} = \frac{P_{\text{intermediate}}}{P_{\text{in}}} = \frac{P_{\text{intermediate}}}{100}$$

$$\therefore P_{\text{intermediate}} = 400\text{ kPa}$$

$$r_{c_{2'-2}} = \frac{P_{\text{intermediate}}}{P_{\text{out}}}$$

$$\Rightarrow 5 = \frac{P_{\text{out}}}{400}$$

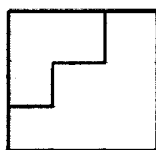
$$\Rightarrow P_{\text{out}} = 2000\text{ kPa} = P_2$$

\therefore No of required compressor = 2 (Answer)

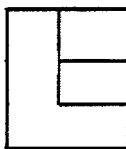
$$4^2 = 20$$

N.B.: This may be a possible solution.

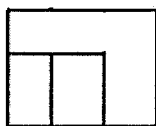
12. Draw FRONT VIEW, TOP VIEW and LHS VIEW.



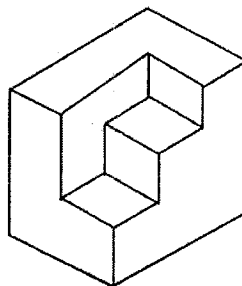
FRONT VIEW



LHS VIEW



TOP VIEW



Sylhet Gas Fields Company Limited (SGFCL)

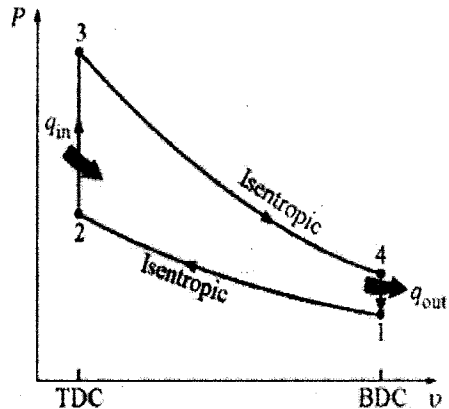
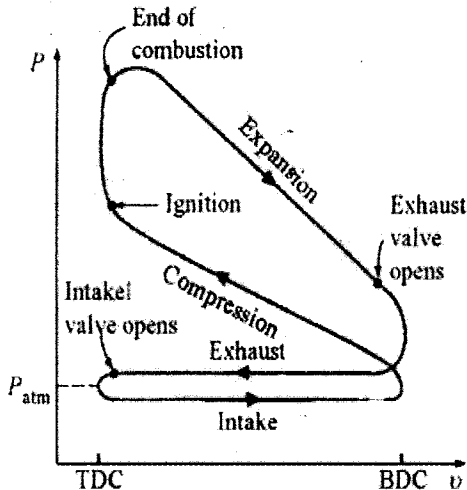
Post: Assistant Engineer(Mechanical)

Time-2:30PM to 4:00PM

Date: 10.03.2017

Exam Hall: ECE Building, BUET

1. Draw the actual and air standard Otto cycle P-V diagram with all thermodynamic processes.



Process 1-2: Reversible adiabatic compression of air

Process 2-3: Heat addition at constant volume

Process 3-4: Reversible adiabatic expansion of air

Process 4-1: Heat rejection at constant volume

2. A boiler steam pressure is 11.5 bar and feed water temperature is 34°C . Dryness function is 0.85. Enthalpy of saturated water = 790 KJ/kg

Enthalpy of saturated steam = 2780 KJ/kg

Enthalpy of feed water = 142.4 KJ/kg

Latent heat of evaporation is 2257 KJ/kg.

(i) Find the specific enthalpy of steam;

(ii) Find the evaporation factor.

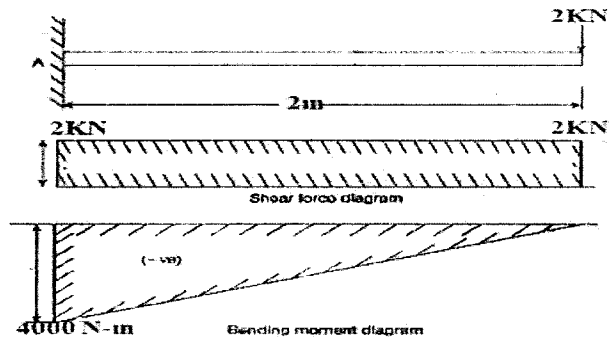
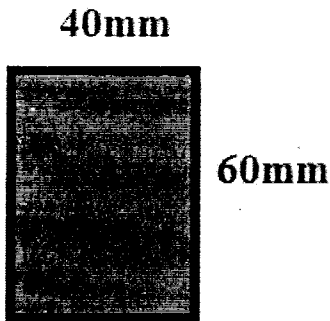
Solution: Given, $h_{f1} = 142.4 \text{ KJ/kg}$, $h_f = 790 \text{ KJ/kg}$, $h_g = 2780 \text{ KJ/kg}$, $x = 0.85$.

$$\begin{aligned} \text{(i) Total enthalpy of steam, } h &= h_f + xh_{fg} = h_f + x(h_g - h_f) \\ &= [790 + 0.85 \times (2780 - 790)] \text{ KJ/kg} \\ &= 2481.5 \text{ KJ/kg} \quad \text{(Answer)} \end{aligned}$$

$$\begin{aligned} \text{(ii) Factor of evaporation} &= \frac{h - h_{f1}}{2257} \\ &= \frac{2481.5 - 142.4}{2257} = 1.04 \quad \text{(Answer)} \end{aligned}$$

3. A cantilever of length 2m fails when a load of 2000N is applied at the free end. If the section of the beam is 40mm×60mm; find the stress at the failure.

Solution:



$$S = \frac{bh^2}{6} = \frac{0.04 \times (0.06)^2}{6}$$

$$= 2.4 \times 10^{-5} \text{ m}^3$$

$$\therefore \delta_f = \frac{M}{S} = \frac{4000}{2.4 \times 10^{-5}}$$

$$\therefore \delta_f = 1.66.67 \text{ MPa (Ans.)}$$

4. Temperatures of inside and outside of a wall are 80°C and 30°C respectively. The wall is 4m × 3m × 0.35m and k for the material is 4.5 w/mk. Determine the heat flow in per minute.

Solution: Given, $T_1 = 80^\circ\text{C}$, $T_2 = 30^\circ\text{C}$, $A = 4 \times 3 = 12 \text{ m}^2$, $dx = 0.35\text{m}$, $k = 4.5 \text{ w/mk}$

$$\therefore Q = -kA \frac{dT}{dx} = -4.5 \times 12 \frac{(30-80) \times 60}{0.35 \times 1000} \text{ KJ/min}$$

$$\therefore Q = 462.86 \text{ KJ/min (Answer)}$$

5. Find the maximum torsional shear stress in a solid shaft of diameter 10mm, applied torque is 30 Nm, and length of the shaft is 4m.

Solution: Given, $T = 30 \text{ Nm}$, $D = 10\text{mm} = 0.01\text{m}$

$$\therefore \tau_{\max} = \frac{16T}{\pi D^3} = \frac{16 \times 30}{\pi \times (0.01)^3} = 152 \text{ MPa (Answer)}$$

6. A motorcyclist runs his vehicle on a curved path of radius 500m. Velocity of motorcycle is 70 km/hr. Determine the acceleration.

Solution: Given, $r = 500\text{m}$, $v = 70 \text{ km/hr} = 19.44 \text{ ms}^{-1}$

$$\therefore a_n = \frac{v^2}{r} = \frac{(19.44)^2}{500} = 0.756 \text{ ms}^{-1} \text{ (Answer)}$$

7. Elaboration: NPSH, BDC, HHV, HVAC, BHP

Answer: NPSH = Net Positive Suction Head.

BDC = Bottom Dead Centre.

HHV = Higher Heating Value.

HVAC = Heating, Ventilation and Air Conditioning.

BHP = Brake Horse Power.

8. A compressor handles 800 cfm air at 30°C and 200KPa. What is the cfm at standard atmospheric condition?

Solution: Given, $V_1 = 800$ cfm, $T_1 = 30^{\circ}\text{C} = 303\text{k}$, $P_1 = 200$ kPa

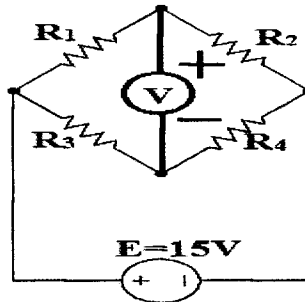
$$P_2 = 101.325 \text{ kPa}, T_2 = 273\text{k}, V_2 = ?$$

We get, $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$$\therefore V_2 = \frac{P_1 V_1 \times T_2}{T_1 \times P_2} = \frac{200 \times 800 \times 273}{303 \times 101.325}$$

$$\therefore V_2 = 1422.73 \text{ cfm} \quad (\text{Answer})$$

9. If $R_1 = 2.2 \Omega$ and $R_2 = R_3 = R_4 = 2.7 \Omega$, Then find the voltmeter reading.



Solution:

We get,

$$V_{3-4} = \frac{R_4}{R_3 + R_4} \times E = \frac{2.7}{2.7 + 2.7} \times 15 = 7.5 \text{ V}$$

$$V_{1-2} = \frac{R_2}{R_1 + R_2} \times E = \frac{2.7}{2.2 + 2.7} \times 15 = 8.27 \text{ V}$$

$$\therefore \text{Voltmeter reading, } V = V_{1-2} - V_{3-4} = 8.27 - 7.5$$

$$\therefore V = 0.765 \text{ V} \quad (\text{Answer})$$

10. Water flows through a pipe in which a manometer is attached at 2 points of that pipe. If the manometer deflection is 3m then find the pressure difference of point 1 and 2 in kPa and m of H_2O .

Solution:

We get,

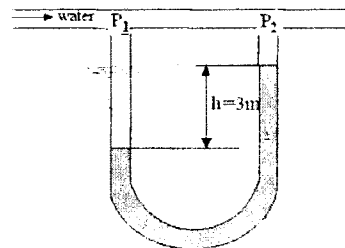
$$P_1 + (h\rho g)_w = P_2 + (h\rho g)_{\text{Hg}}$$

$$\Rightarrow P_1 - P_2 = (h\rho g)_{\text{Hg}} - (h\rho g)_w$$

$$= 3 \times 13.6 \times 9.81 - 3 \times 1 \times 9.81$$

$$\therefore P_1 - P_2 = 370.818 \text{ kPa} \quad (\text{Answer})$$

$$\text{or, } P_1 - P_2 = 37.8 \text{ m of } \text{H}_2\text{O} \quad (\text{Answer})$$



8. A compressor handles 800 cfm air at 30°C and 200KPa. What is the cfm at standard atmospheric condition?

Solution: Given, $V_1 = 800$ cfm, $T_1 = 30^\circ\text{C} = 303\text{k}$, $P_1 = 200$ kPa

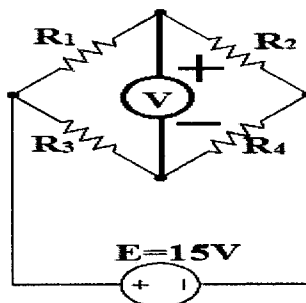
$P_2 = 101.325$ kPa, $T_2 = 273\text{k}$, $V_2 = ?$

We get, $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$$\therefore V_2 = \frac{P_1 V_1 \times T_2}{T_1 \times P_2} = \frac{200 \times 800 \times 273}{303 \times 101.325}$$

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We get,

$$V_{3-4} = \frac{R_4}{R_3 + R_4} \times E = \frac{2.7}{2.7 + 2.7} \times 15 = 7.5 \text{ V}$$

$$V_{1-2} = \frac{R_2}{R_1 + R_2} \times E = \frac{2.7}{2.2 + 2.7} \times 15 = 8.27 \text{ V}$$

$$\therefore \text{Voltmeter reading, } V = V_{1-2} - V_{3-4} = 8.27 - 7.5$$

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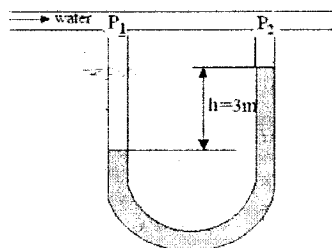
Solution:

We get,

$$\begin{aligned} P_1 + (h\rho g)_w &= P_2 + (h\rho g)_{\text{Hg}} \\ \Rightarrow P_1 - P_2 &= (h\rho g)_{\text{Hg}} - (h\rho g)_w \\ &= 3 \times 13.6 \times 9.81 - 3 \times 1 \times 9.81 \end{aligned}$$

$$\therefore P_1 - P_2 = 370.818 \text{ kPa} \quad (\text{Answer})$$

$$\text{or, } P_1 - P_2 = 37.8 \text{ m of } \text{H}_2\text{O} \quad (\text{Answer})$$



Bangladesh Power Development Board (BPDB)**Post: Assistant Engineer(Mechanical)****Time-10.00AM to 11.30AM****Date: 09.11.2016****Exam Hall: BUET****Non-departmental**

1. সংসপ্তক কার লেখা? **শহীদুল্লাহ কায়সার।**
2. আনারস ও চাবি কোন ভাষার শব্দ? **পর্তুগীজ।**
3. নয়নের প্রকৃতি-প্রত্যয় কি? **নী+অনট।**
4. দ্বিপ এর সমার্থক শব্দ কোনটি? **হাতি।**
5. তুষারশুভ্র কোন সমাস? **উপমান কর্মধারয় সমাস।**
6. রাত্রী এর সমার্থক শব্দ নয় কোনটি? **বারিদ।**
7. কোন সমাসে সমাহার ব্যবহার হয়? **দ্বিগু সমাসে।**
8. 'তদবধি' শব্দের সন্ধি বিচ্ছেদ কোনটি? **তৎ+অবধি**
9. মুগয়া অর্থ কি? **হরিণ শিকার**
10. বিষাদ সিন্ধু এর লেখক কে? **মীর মশাররফ হোসেন**
11. বাংলায় যতি চিহ্নের প্রবর্তক কে? **ঈশ্বরচন্দ্র বিদ্যাসাগর।**
12. অভিনিবেশ শব্দের অর্থ কি? **মনোযোগ।**
13. বাংলা ভাষার আধুনিক যুগের নিদর্শন কি? **বাংলা গদ্য।**
14. কেনটি গুরু গভীর? **সাধু ভাষা।**
15. If $x > 31$ and $y < 59$, x and y r prime number then $x+y=?$ **Answer: 90**
16. Who is the highest wicket taker in Bangladesh vs England match? **Mehedi Hasan Miraz**
17. Who is the architect of national shohid minar? **Hamidur Rahman**
18. Where the head quarter of UN-ESCAP is? **Bangkok**
19. ___ emits from light? **Photons**
20. Who calculates the height of Everest? **Radhanath Sikdar**
21. Neela's age was 15 years and 11 months at 11th November 2006. Her birthday was- **14th December 1990**
22. Which is used for store photos, video, audio etc.? **File Sarver**
23. Where hard-rock is found? **Madhyapara**
24. What is the power house of cell? **Mitrocondia**
25. Who is the first Bengali woman who conquers Everest? **Nishat Majumder**
26. Bangladesh contains the India and Myanmar border with the district- **Rangamati**
27. 1,1,2,3,5,8,13,21,34,? **Answer: 55.**
28. How many two digit number other than 13 which increases by 18 when the digits changes its position? **Answer: 6**
28. The bright star in night is- **Sirius**
29. Full meaning of URL is- **Uniform Resource Locator**

30. Electric bulb contains the gas- **Nitrogen**
31. Boiling is a __ process? - **Physical Process**
32. Nanometer is equal to ___ of meter? **Billionth**
33. If floating ice melt in a glass what will happen? – **water level will same**
34. If ring bell in space what will happen? **Answer: Not hear**
35. Why we can't see anything in darkness? **Answer: No light from the object comes to our eye**
36. Which parts of plants reproduce?
37. What is the unit of nerve cell? - **Neuron**
38. Which disease not spread isn't spread by virus? - **Colera**
39. Which is a chemical reaction? - **Candle burning**
40. Which is valid web site?-
41. First election after freedom war was held in – **1973.**
- (42-46).Correct spelling: **Perseverance, Accommodate, Deductible, Commitment, Consensus**
47. Which mirror is used in motor cycle for rear view?- **convex**
48. In Electric iron what is happened? - **Electric energy to heat energy**
49. In chemical reaction energy is - a) released b) absorbed c)**both** d)none of this
50. প্রসারিত এর বিপরীত শব্দ কোনটি? **আকৃঙ্কন**
51. Who invented that the earth moves round? - **Copernicus**

Departmental

1. Center of gravity of a hemisphere lies __ below the center. – **$3r/8$**
2. Euler formula is not applicable for - **slenderness ratio less than 80**
3. Stoichiometric air fuel ratio means – **chemically correct air fuel ratio by volume or by mass**
4. When the fluid is at rest then shearing force will be- **zero.**
5. After critical thickness if insulation is added – **heat flux will decrease**
6. For $P=2000W$ and $N=500/\pi$ find $T=?$ – **$120Nm$**
7. After leaving evaporator what is the state of refrigerant- **superheated**
8. During heating and humidification the final relative humidity- **can be lower or higher than that of the entering air**
9. Diesel is compared to petrol – **more difficult to ignite**
10. Which one is not correct? a) Bomb calorimeter is used to measure the HHV of liquid or solid fuels
b) Flash point is higher than the fire point
Answer: b)

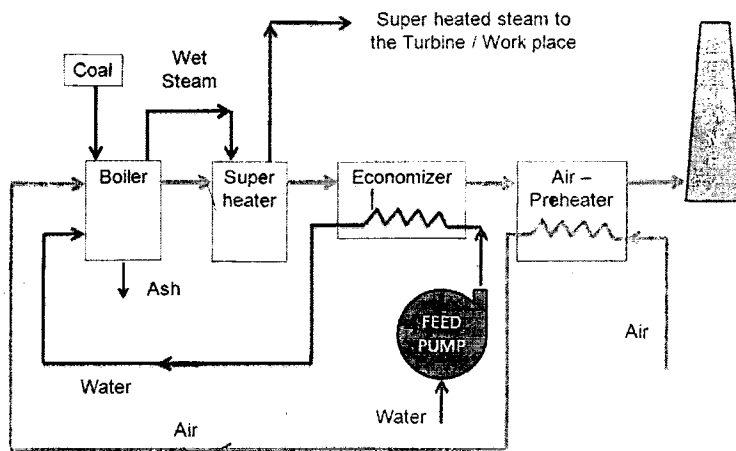
11. Determine the power transmitted by a belt drive on a pulley having dia 0.6 m and 200 r.p.m. The tension on the tight and slack side of the pulley was given 2500N and 1226N respectively.

Answer: Given, $T_1 = 2500\text{N}$; $T_2 = 1226\text{N}$; $D = 0.6\text{m}$; $N = 200\text{ rpm}$

$$\begin{aligned}\text{We get, Power} &= \text{Torque} \times \text{Angular Velocity} = F \times \frac{D}{2} \times \frac{2\pi N}{60} = (T_1 - T_2) \times \frac{D}{2} \times \frac{2\pi N}{60} \\ &= (2500 - 1226) \times \frac{0.6}{2} \times \frac{2\pi \times 200}{60} \\ &= 8004.78\text{W} = 8.005\text{KW (Answer)}\end{aligned}$$

Another Solution, $P = Fv$

12. Draw a schematic diagram of a boiler with economizer, super heater and air preheater.



Schematic Diagram of Boiler Plant

13. Determine the allowable cross section area of a bar of length of 2m, the maximum allowable tensile stress 150MPa and $E = 200\text{GPa}$. The deformation due to tensile pull is 0.003m.

Solution:

Cannot recall the data so only solution procedure is provided:

First apply this formula and find the area $\sigma = \frac{P}{A}$; Or, $A = \frac{P}{\sigma} = \frac{P}{\sigma}$

And then apply this formula and find the area,

$$\delta = \frac{PL}{AE}$$

Now, by comparing these two area values select the maximum allowable area. (Answer)

14. In a pitot tube stagnation and static pressure difference is 9.8 Pa; Density of air 1.23 kg/m³. Calculate the velocity of flowing fluid.

Solution: Given, $P_s - P = 9.8 \text{ Pa}$; $\rho = 1.23 \text{ kg/m}^3$.

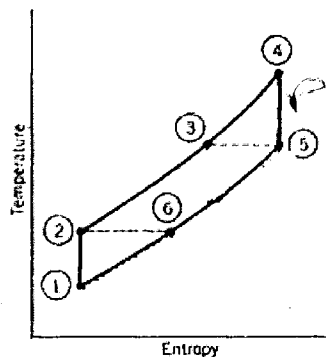
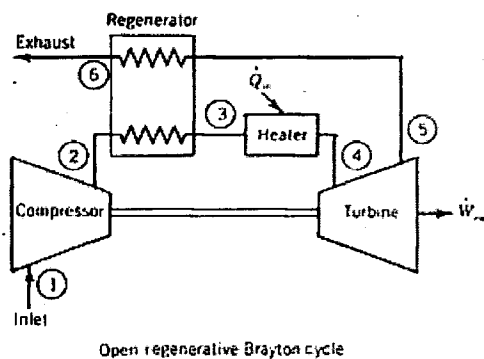
We get,

$$P_s - P = \frac{1}{2} \rho v^2$$

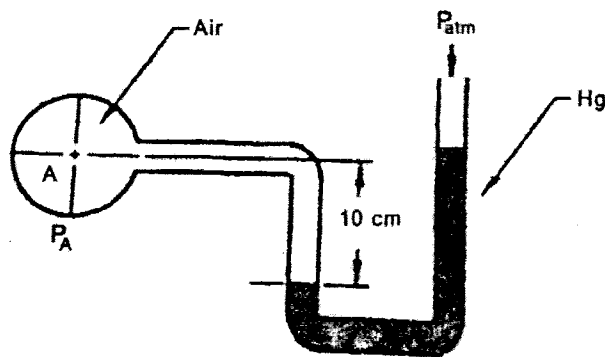
$$\text{Or, } 9.8 = \frac{1}{2} \times 1.23 \times v^2$$

$$\text{Or, } V = 4.00 \text{ m/s (Answer)}$$

15. Draw the Schematic diagram of Brayton cycle with regeneration with T-S diagram.



16. Find the gauge pressure at the Tank.



Solution: We get,

$$P_A + 1.21 \times 9.8 \times 0.1 - 13.6 \times 9.8 \times 1000 \times 0.10 = 0$$

$$\Rightarrow P_A + 1.1858 - 13328 = 0$$

$$\Rightarrow P_A = 13326.81 \text{ Pa}$$

$$\Rightarrow P_A = 13.33 \text{ KPa (Answer)}$$

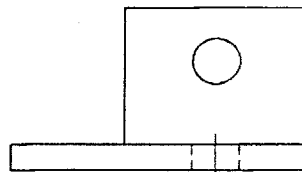
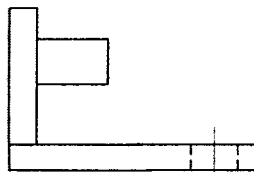
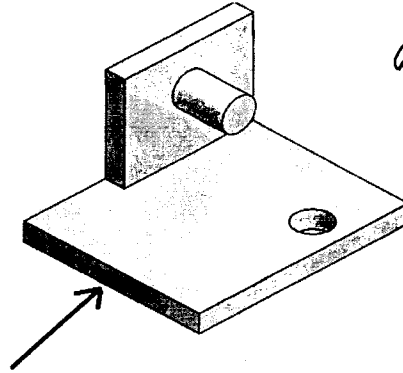
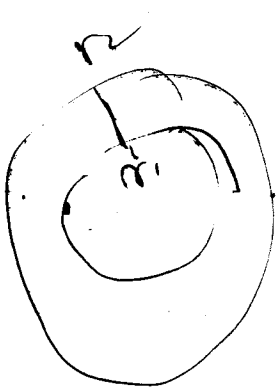
17. Write the expression of Joule-Thomson effect. And temperature of gas during throttling process for the cases of temperature decrease, increase and same i.e, negative, positive or same?

Answer: Expression for the Joule-Thomson Effect is

$$\mu = \left(\frac{\delta T}{\delta P} \right)_h = \frac{V}{C_p} (\alpha T - 1)$$

Joule-Thomson Coefficient	Temperature
Positive (+)	Decrease
0	Same
Negative (-)	Increase

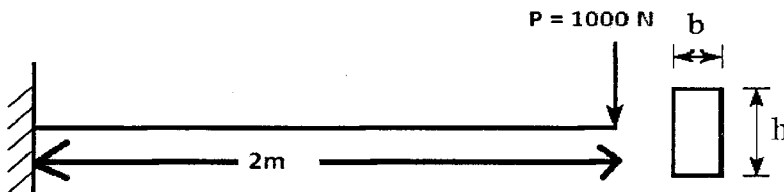
18. Draw the FRONT VIEW and RHS VIEW.



$$V \sim \frac{1}{2} \pi r^2 \frac{dT}{dr}$$

$$\frac{dT}{dr} \sim \frac{2V}{\pi r^2}$$

19. A cantilever beam that carries a point load $p = 1000\text{N}$ at its free end of length is 2m , width of 0.25m . If the stress is 100MPa , find the height of the beam.



Solution: Given that, $b = 0.25\text{ m}$; $P = 1000\text{ N}$; $\sigma = 100\text{MPa}$.

We get, $\sigma = \frac{M}{S}$

Here, $S = \frac{bh^2}{6} = \frac{0.25 \times h^2}{6}$; $M = PL = 1000 \times 2 = 2000\text{Nm}$.

$$\sigma = \frac{2000 \times 6}{0.25 \times h^2}$$

$$\Rightarrow 100 \times 10^6 = \frac{2000 \times 6}{0.25 \times h^2}$$

$$\Rightarrow h = 0.022\text{m}$$

$$\therefore h = 0.022\text{m (Answer)}$$

$$\left[\frac{Q}{\delta} \right] \sim \frac{1}{2} \pi r^2 \left[\frac{dT}{dr} \right]_T$$

20. A hollow shape spherical vessel of outer radius 200 mm and inner radius 100 mm, the thermal conductivity is 200 w/mk. If the temperature difference between inside and outside is 100°C and 50°C . Find the heat transfer rate?

Solution:

Given, $r_2 = 0.2\text{m}$; $r_1 = 0.1\text{m}$;

$$T_1 - T_2 = 50\text{K}; k = 200 \text{ w/mK}$$

$$\begin{aligned} \text{We know that rate of heat leakage, } Q &= \frac{4\pi k r_1 r_2 (T_1 - T_2)}{r_2 - r_1} \\ &= \frac{4\pi \times 0.2 \times 0.1 \times 200 \times 50}{0.2 - 0.1} = 25.13\text{KW (Answer)} \end{aligned}$$

Pashchimanchal Gas Company Limited (PGCL)

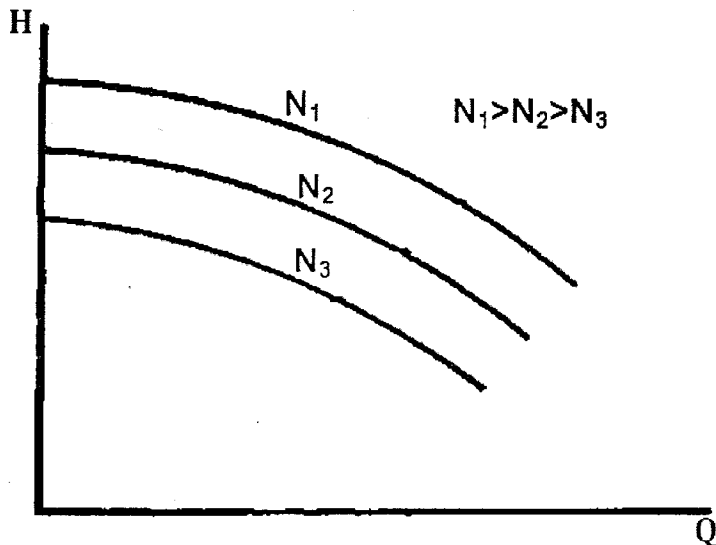
Post: Assistant Engineer (Mechanical)

Time-3.30PM to 5.00PM

Date: 19.05.2017

Exam Hall: ECE Building, BUET

1. Draw H-Q curve of centrifugal pump. Show effect of variation of impeller rpm on the graph.



2. A cylinder of 60 liter volume contains gas at 10000kPa at 25°C . Some gas released from this cylinder, pressure falls at 4000kPa and temperature becomes 15°C . Assuming $R = 0.296\text{KJ/Kg}$ then find the amount of gas released.

Solution: Given, $V = 60\text{L} = 60 \times 10^{-3}\text{m}^3$, $P_1 = 10000\text{KPa}$; $T_1 = 25^{\circ}\text{C} = 298\text{K}$;
 $P_2 = 4000\text{kPa}$; $T_2 = 15^{\circ}\text{C} = 288\text{K}$; $R = 0.296\text{KJ/Kg}$

We get,

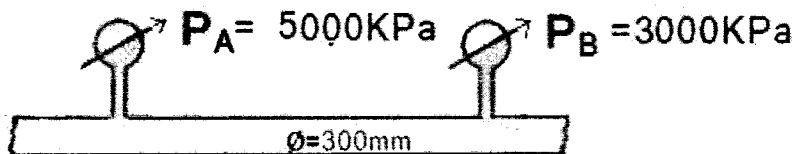
$$\begin{aligned} P_1 &= \rho_1 RT_1 \\ \therefore \rho_1 &= \frac{P_1}{RT_1} = \frac{10000}{0.296 \times 298} \\ &= 113.36 \text{ Kg/m}^3 \end{aligned}$$

$$\begin{aligned} P_2 &= \rho_2 RT_2 \\ \therefore \rho_2 &= \frac{P_2}{RT_2} = \frac{4000}{0.296 \times 288} \\ &= 46.92 \text{ Kg/m}^3 \end{aligned}$$

$$\therefore \rho_1 - \rho_2 = 113.36 - 46.92 = 66.44 \text{ Kg/m}^3$$

$$\therefore \text{Amount of gas released} = 66.44 \times 60 \times 10^{-3} = 3.98 \text{ Kg (Answer)}$$

3. In a gas pipeline pressure gage are 2Km apart and readings are shown. Average gas density is 40 Kg/m^3 . Determine gas transport rate in Mm^3/day . Friction factor is 0.005.



Solution: Given, $L=2\text{Km}=2000\text{m}$; $\rho=40 \text{ Kg/m}^3$; $f=0.005$; $P_A=5000 \text{ KPa}$; $P_B=3000 \text{ KPa}$; $D=0.3\text{m}$

$$\text{We get, } \frac{P_A}{\gamma} = \frac{P_B}{\gamma} + h_f$$

$$\text{or, } \frac{P_A}{\gamma} = \frac{P_B}{\gamma} + \frac{fv^2}{2gD}$$

$$\text{or, } \frac{5000 \times 10^3}{40 \times 9.81} = \frac{3000 \times 10^3}{40 \times 9.81} + \frac{0.005 \times 2000 \times v^2}{2 \times 9.81 \times 0.3}$$

$$\text{or, } V = 54.77 \text{ m/s}$$

$$\therefore Q = AV = \frac{\pi}{4} d^2 \times V = \frac{\pi}{4} 0.3^2 \times 54.77$$

$$= 3.87 \text{ m}^3/\text{s} = 0.335 \text{ Mm}^3/\text{day (Answer)}$$

4. Gas is compressed adiabatically from suction temperature of 15°C and compression ratio of 2. Calculate the rise in gas temperature (ΔT) due to this compression. Assume $\gamma = 1.4$ and compressibility factor $Z=1$ for both suction and discharge.

Solution: Given, $T_1 = 15 + 273 = 288 \text{ K}$; $\frac{P_2}{P_1} = 2$; $\gamma = 1.4$

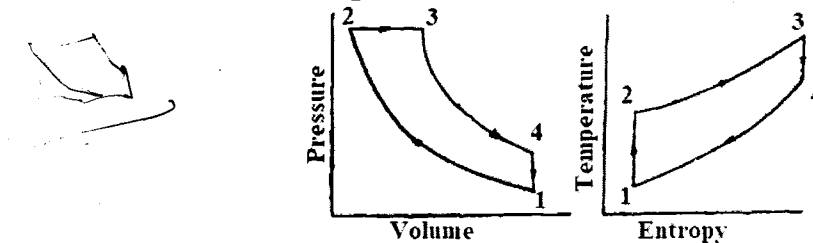
$$\text{We get, } \frac{T_2}{T_1} = \left(\frac{P_2}{P_1} \right)^{\frac{\gamma-1}{\gamma}}$$

$$\text{or, } \frac{T_2}{288} = (2)^{\frac{1.4-1}{1.4}}$$

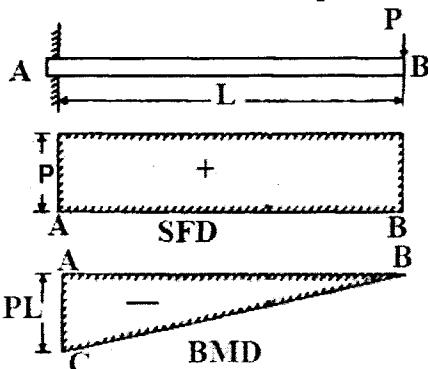
$$\begin{aligned} \text{or, } T_2 &= 288 \times (2)^{\frac{1.4-1}{1.4}} \\ &= 351.08 \text{ K} = 78.08^\circ\text{C} \end{aligned}$$

$$\therefore \Delta T = 78.08 - 15 = 63.07^\circ\text{C (Answer)}$$

5. Draw the P-V and T-S diagram for CI engine.



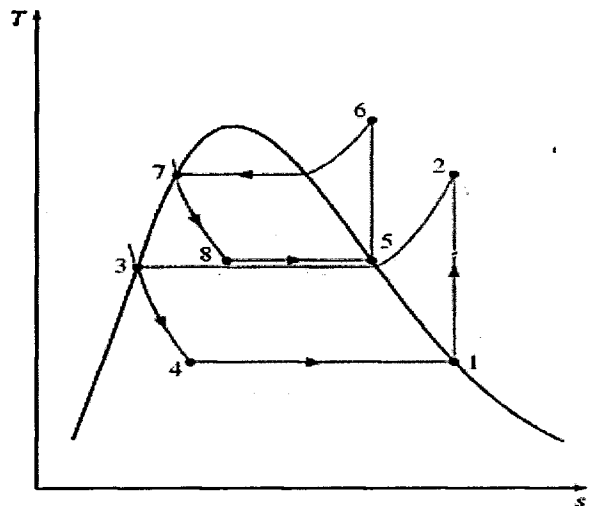
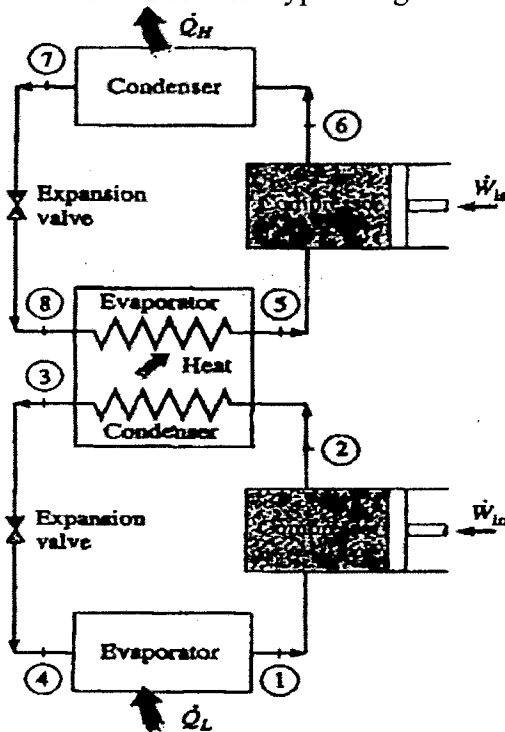
6. A cantilever of length L carries a point load P at the tip of the beam. Draw the SFD and BMD and also find point at which critical stress occurs.



Critically stressed occurs near the point at which the support is attached.

7. A refrigeration system is given the following diagram. What type of this refrigeration system is? Draw the corresponding T-S diagram.

Answer: This is cascade type refrigeration.



8. A 2m long and 10mm diameter tube is generating heat at rate of 8KW. The tube is exposed in ambient air at 30°C. If heat transfer coefficient is 2 KW/m²°C, estimate temperature at the tube surface applying steady state heat transfer.

Solution: Given, L= 2m; D = 10mm = 0.01m; Q = 8KW = 8000W;

$$T_a = 30^\circ\text{C} = 303\text{K}; A = \pi \times D \times L = \pi \times 0.01 \times 2 = 0.063 \text{ m}^2$$

$$h = 2 \text{ KW/m}^2\text{°C} = 2000 \text{ W/m}^2\text{°C}, T_s = ?$$

$$\text{We get, } Q = h A (T_s - T_a)$$

$$\therefore 8000 = 2000 \times 0.063 \times (T_s - 303) = 126 \times (T_s - 303)$$

$$\Rightarrow (T_s - 303) = 63.5$$

$$\Rightarrow T_s = 366.66 \text{ K} = 93.5^\circ\text{C} \text{ (Answer)}$$

9. Find the least area moment of inertia and corresponding radius of gyration for the shaded area in the following fig. Given circle radius is 10mm and rectangular slot size is 2mm×5mm.

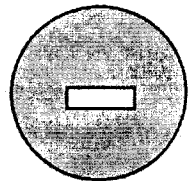
Solution:

$$\begin{aligned} \text{Area Moment of inertia} &= \frac{\pi r^4}{4} - \frac{bh^3}{12} \\ &= \frac{\pi(0.01)^4}{4} - \frac{0.002 \times (0.005)^3}{12} \\ &= 7.83 \times 10^{-9} \text{ m}^4 \text{ (Answer)} \end{aligned}$$

$$\text{Radius of gyration, } K = \sqrt{\frac{I}{A}}$$

$$\text{Area, } A = \pi r^2 - bh = 3.04 \times 10^{-4}$$

$$\therefore K = \sqrt{\frac{7.83 \times 10^{-9}}{3.04 \times 10^{-4}}} = 5.07 \times 10^{-3} \text{ m} = 5.07 \text{ mm} \text{ (Answer)}$$



10. The module of a mating spur gear set is 3mm. Pressure angle 25°, number of teeth on pinion 20 and gear ratio is 3, driver pinion runs at 1500 rpm and transmits 1200W to gear. Calculate: Driving force and separating force acting on gears.

Solution: Given, m=3mm; $\theta=25^\circ$; T=20; gear ratio=3; N=1500rpm; P=1200W

Driving Force, $F_t = ?$ and Separating Force, $F_n = ?$

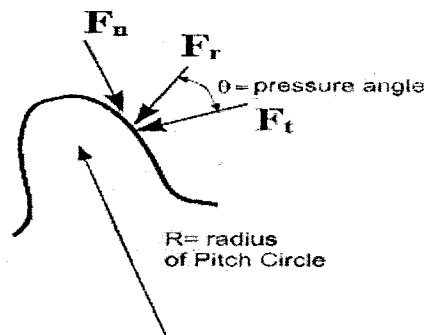
$$\text{We get, } m = \frac{D}{T}$$

$$\text{Or, } D = m \times T = 0.003 \times 20 = 0.06 \text{ m}$$

$$\text{Now, } P = F_t V$$

$$\begin{aligned} \text{Or, } F_t &= \frac{P}{V} = \frac{P \times 60}{\pi D N} = \frac{1200 \times 60}{\pi \times 0.06 \times 1500} \\ &= 254.65 \text{ N (Answer)} \end{aligned}$$

$$\begin{aligned} \text{Again, } F_n &= F_t \tan \theta \\ &= 254.65 \times \tan 25^\circ \\ &= 118.74 \text{ N (Answer)} \end{aligned}$$



11. Write the formula for finding

a) Maximum torsional shear stress developed in shaft due to torsion.

b) Maximum bending stress developed in beam of circular cross section due to pure bending.

Answer:

$$a) \tau_{\max} = \frac{16T}{\pi D^3}$$

$$b) \sigma_{\max} = \frac{MC}{I} = \frac{M \frac{D}{2}}{\frac{\pi D^4}{64}} = \frac{32M}{\pi D^3}$$

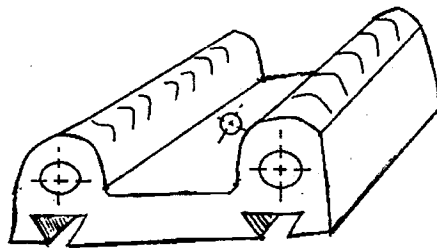
12. A boiler is subjected to an internal pressure 50MPa. If the boiler has a mean radius is 300mm and hoop stress is 150MPa. Find a) the wall thickness and also find the b) Longitudinal stress in its wall.

a) We know, Hoop stress $\sigma_t = \frac{PD}{2t}$

$$\Rightarrow t = \frac{50 \times 300 \times 2}{2 \times 150} = 100 \text{mm (Answer)}$$

b) Longitudinal stress, $\sigma_l = \frac{PD}{4t} = \frac{50 \times 600}{4 \times 100} = 75 \text{MPa (Answer)}$

13. A CI Block is given below. Neglecting the dimensions draw TOP view, FRONT view and RHS view.



Meghna Petroleum Limited (MPL)

Post: Assistant Engineer(Mechanical)

Time-10.00AM to 11.30AM

Date: 06.01.2017

Exam Hall: BUET

Departmental

11. In Automobile, “4×4/MPFI/3.0L/16V/VVTi”, What does this advertise mean?

Answer:

4×4 = 4 wheels and All 4 wheels driven.

MPFI = Multi point Fuel Injection

3.0L= Volume of charge is 3 Litre or 3000 cubic centimeter

16V = Engine has 16 valves.

VVTi= Variable Valve Timing with intelligence

12. Draw block diagram and show all the processes of Rankine Cycle in T-S diagram

Answer: Same as Previous year question.

13. A pump flow rate of water is 0.01m³/s the pressure 1000KPa, the efficiency with a motor is 67%. Find Power in KW.

Solution: Same as Previous year question

14. 7250kg ice is melt in 24 hours at 0°C to 0°C. Find Capacity in Ton. (Latent Heat of ice to melt=333.6KJ/Kg, 1 Ton =3.5KW)

Solution: Same as Previous year question.

$$Q = \frac{m \cdot l_f}{24 \times 3600} = \frac{7250 \times 333.6}{24 \times 3600} = 27.993 \text{ KW} = 8 \text{ ton (Answer)}$$

15. In a Counter flow heat exchanger, hot fluid enters at 240°C and leaves at 80°C. Cold fluid enters at 40°C and leaves at 120°C. Find LMTD.

Solution: Same as Previous year question

16. In a straight solid rod (dia 32mm, E=200GPa) is kept in a circular plate of radius 1m. Determine bending stress, that can't exceed proportional limit.

Solution: Given,

D=32mm=0.032m; Radius of curvature=1m, E=200GPa, Bending Stress, $\sigma_b = ?$

$$\text{We get, } \frac{M}{I} = \frac{\sigma_b}{y} = \frac{E}{R}$$

$$\text{Then, } \sigma_b = \frac{E}{R} \times y = \frac{200 \times 10^9}{1} \times 0.016 = 3.2 \text{ GPa (Answer)}$$

17. Draw a typically stress-strain diagram for mild steel specimen. Show each point.

18. Answer: Same as Previous year question.

19. In a thin wall pressure vessel, mean radius is 50mm and thickness 2.5mm. Find internal pressure if the maximum allowable normal stress is 150MPa.

Solution: Same as Previous year question

20. Name 4 types of gears. Mention applications of worm gear.

Solution: Same as question-1 Power Grid Company of Bangladesh (PGCB)-2015

21. Draw Top and Front sectional view.

Non-Departmental

বাংলা

১. পর্যন্ত সন্ধি বিচ্ছেদ= পরি + অন্ত
২. মাতা কোন শব্দ- তৎসম
৩. কবিরাজ এর লিঙ্গান্তর- কোনটিই নয়
৪. কবর নাটকটি কার লেখা- মুনীর চৌধুরি
৫. মানুষ কোন লিঙ্গ- উভয় লিঙ্গ
৬. বাংলা বর্ণমালায় বর্ণের সংখ্যা কয়টি-৫০
৭. মা শিশুকে চাঁদ দেখাচ্ছে, এখানে মা কোন কারক- কর্তৃ কারক
৮. আমি ভাত খাই, এখানে ভাত কোন কারকে কোন বিভক্তি- কর্মে শূন্য
৯. কোনটি দিগু সমাস- সেতার
১০. কোন বানানটি শুদ্ধ- সমীচীন
১১. অশ্ব শব্দের অর্থ কি- ঘোড়া
১২. তরঙ্গ এর সমার্থক শব্দ কোনটি- ঢেউ
১৩. নিচের কোনটি বিজ্ঞতিভূষন বন্দোপধ্যায়ের লেখা- অহনি সংকেত
১৪. বুপসী বাংলা কার লেখা- জীবনানন্দ দাস

১৫. এক কথায় প্রকাশ, যে উপকারীর উপকার স্বীকার করে না - কৃতঘ্ন
 ১৬. ঘাটের মরা বাগধারার অর্থ কি- অতি বৃদ্ধ

Electricity Generation Company of Bangladesh(EGCB)

Post: Assistant Engineer(Mechanical)

Time-10.00AM to 11.30AM

Date: 07.04.2017

Exam Hall: BUET

11. Diesel Cycle efficiency related math.
 12. Draw block diagram of vapor compression refrigeration system and show main parts of it and also show P-h and T-S diagram with sub-cooling.

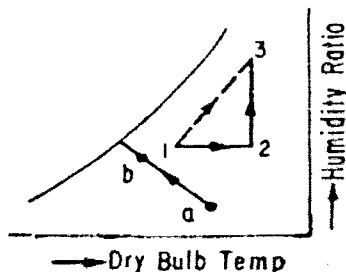
Answer: Same as Previous year question.

13. Compressor P_1 and P_2 given n compressor ratio given. How many compressor will need if the compression ratio between 3 to 5. Where inlet pressure of natural gas in pipe 100kPa & outlet pressure maximum 2000 kPa.

Solution: Same as Previous year question. (BGFCL-2017)

14. LMTD of Parallel flow heat exchanger.
 15. Draw Psychrometric Chart and show heating & humidification in a line and mention different points.

Answer: Heating and humidification process of moist air is shown in figure. Line 1-2 shows heating at constant humidity ratio and line 2-3 shows the humidification process at constant dry bulb temperature. The line 1-3 shows the heating and humidification process.



16. Maximum stress, allowable stress and area are given. Find out safety factor and maximum allowable pull.
 17. Find the power required to drive a centrifugal pump which delivers $0.04 \text{ m}^3/\text{s}$ of water to a height of 20 m. Pipe diameter is 15 cm and length is 100 m long. The overall efficiency of the pump is 70% and coefficient of friction $f = 0.015$.

Solution: Same as Previous year question.

18. Elaborate the terms: VRF, AHU, HVAC, ASHRAE, FCU, TOR

Answer: VRF- Variable Refrigerant Flow
 AHU-Air Handling Unit

HVAC- Heating, ventilation and air conditioning.

ASHRAE- American Society of Heating, Refrigerating and Air-Conditioning Engineers.

FCU- Fan coil unit.

TOR- Time Out of Refrigeration.

19. An impulse turbine develops 4500 KW under a head of 200 metres. The turbine runner has a speed of 200 r.p.m and discharges 0.8 cubic metre of water per second. If the head on the same turbine falls during summer season to 184.3 meters, find the new discharge power and speed of the turbine. (Similar)

Solution: Given, $P = 4500 \text{ KW}$; $H = 200\text{m}$; $Q = 0.8 \text{ m}^3/\text{s}$; and $H_1 = 184.3\text{m}$

New discharge of the turbine

We know that new discharge of the turbine,

$$\begin{aligned} Q_1 &= Q \times \left(\frac{H_1}{H_2}\right)^{1/2} = 0.8 \times \left(\frac{184.3}{200}\right)^{1/2} \text{ m}^3/\text{s} \\ &= 0.8 \times 0.96 = 0.768 \text{ m}^3/\text{s} \quad \text{Answer} \end{aligned}$$

New power of the turbine

We know that new power of the turbine,

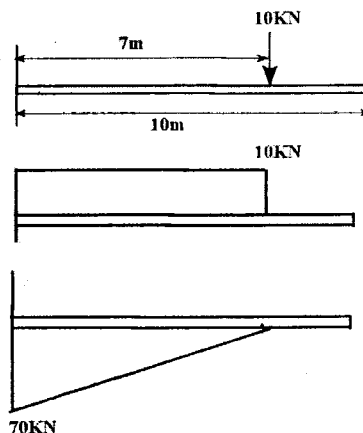
$$\begin{aligned} P_1 &= P \times \left(\frac{H_1}{H_2}\right)^{3/2} = 4500 \times \left(\frac{184.3}{200}\right)^{3/2} \text{ KW} \\ &= 4500 \times 0.88 = 3960 \text{ KW} \quad \text{Answer} \end{aligned}$$

New speed of the turbine,

We also know that new speed of the turbine,

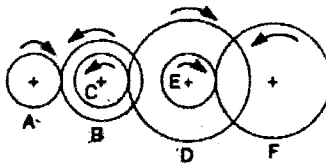
$$\begin{aligned} N_1 &= N \times \left(\frac{H_1}{H_2}\right)^{1/2} = 200 \times \left(\frac{184.3}{200}\right)^{1/2} \text{ r.p.m} \\ &= 200 \times 0.96 = 192 \text{ r.p.m} \quad \text{Answer} \end{aligned}$$

20. Draw SFD and BMD.



21. The gearing of a machine tool is shown in fig. below. The motor shaft is connected to a gear A and rotates at 975 r.p.m. The gear wheels B, C, D and E are fixed to parallel shafts rotating together. The final gear F is fixed on the output shaft. What is the speed of gear F? The number of teeth on each gear are as given below

Gear	A	B	C	D	E	F
No. of Teeth	20	50	25	75	26	65

**Solution:**

Given: $N_A = 975$ r.p.m.; $T_A = 20$; $T_B = 50$; $T_C = 25$; $T_D = 75$; $T_E = 26$; $T_F = 65$

Let, N_F = Speed of gear F i.e Last driven or follower

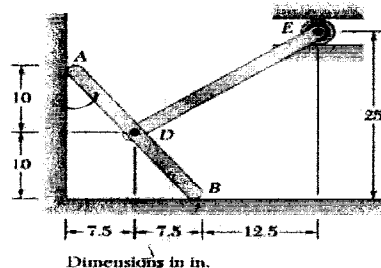
We know that,

$$\frac{\text{Speed of the first driver}}{\text{Speed of the last driven}} = \frac{\text{Product of no. of teeth on drivers}}{\text{Product of no. of teeth on drivers}}$$

$$\text{or, } \frac{N_A}{N_F} = \frac{50 \times 75 \times 65}{20 \times 25 \times 26} = 18.75$$

$$\therefore N_F = \frac{N_A}{18.75} = \frac{975}{18.75} = 52 \text{ r.p.m. (Ans.)}$$

22. Two 25-in. rods are pin-connected at D as shown. Knowing that B moves to the left with a constant velocity of 24 in./s, determine the angular velocity of each rod.

**Solution:**

Rod AB: Draw lines perpendicular to V_A and V_B to locate instantaneous center C_{AB} :

$$V_B = BC_{AB}\omega_{AB}$$

$$\text{or, } 24 = 20\omega_{AB}$$

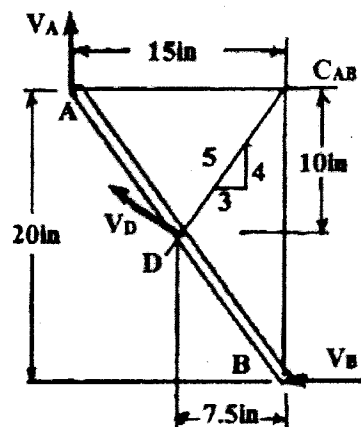
$$\text{or, } \omega_{AB} = 1.2 \text{ rad/s} \sim$$

(Answer)

Velocity of D:

$$V_D = DC_{AB}\omega_{AB}$$

$$= 12.5 \times 1.2 = 15 \text{ in/s (Ans.)}$$



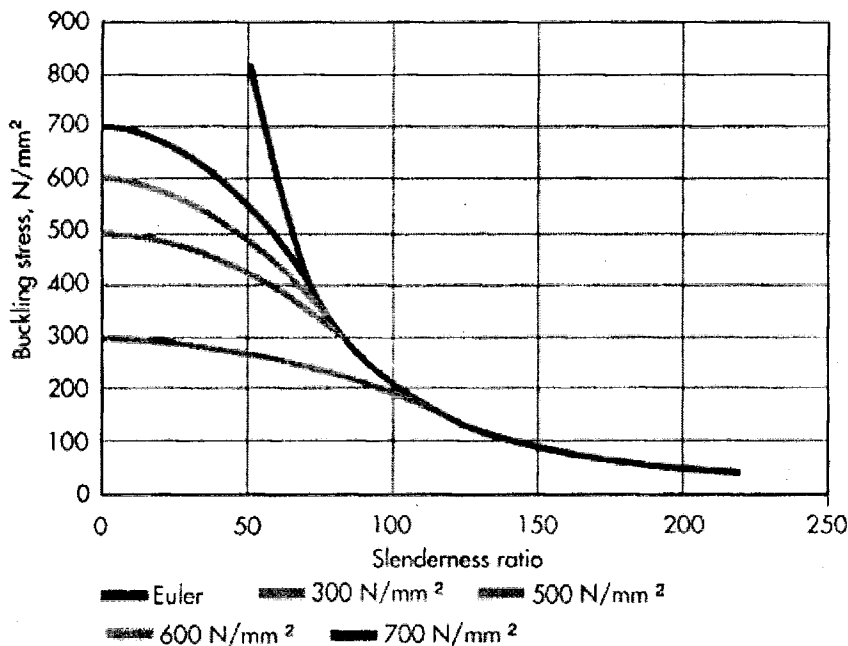
BUET MSc-2017

Date:

Exam Hall: BUET

1. Strain stress diagram of steel.
2. Schematic diagram of vapor absorption refrigeration cycle.
3. Load factor, diversity factor, Capacity factor.
4. Curve of slenderness ratio and buckling load.

Answer:



5. T-S diagram and block diagram of combined cycle power plant.
6. B.H.P of an engine is x kw, thermal efficiency is $y\%$. Find out mass flow rate of fuel if calorific value is 40,000.
7. Length of steel rod x m, force acting on it is y N, and torque z N-m.
8. A steam turbine operates on head of H , η is $x\%$ and flow rate is y m^3/s . Find out power.
9. A pipe has a diameter of x cm and the flow rate is y m^3/hr . Calculate Reynolds number based on the center line velocity of the pipe.
10. Which one has better heat transfer
 - (i) film vs drop wise- **drop wise**
 - (ii) Laminar vs turbulence- **turbulence**

11. Write down which stress is prominent on the following

- (i) Leaf spring of a car- Tensile and compressive stress
- (ii) Helical compression spring- Shear/ torsional stress

12. Write down the equation of LMTD for counter flow heat Exchanger with figure.

13. A iron pipe of 85°C is dropped into a 25°C water. Calculate the final temperature of the mixture. Mass of water and density of iron given.

14. Pitch diameter of a gear, pressure angle and developed R.P.M has given. Find driving force and separating force.

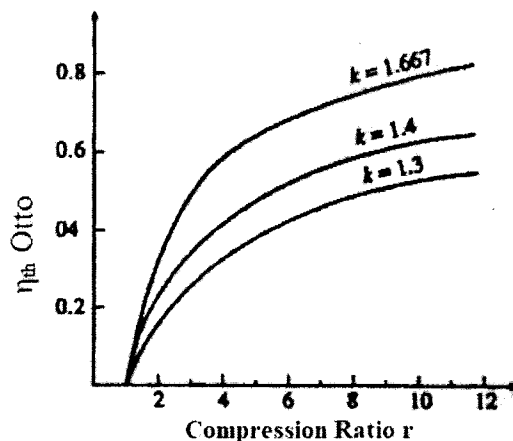
15. Why case hardening is done in gear teeth?

Answer: Case hardening creates a layer to make the tooth harden. It also resists wear and scoring caused by driction as gear teeth rub and wear against each other.

16. $P = T\omega$ and $\delta = \frac{16T}{\pi d^3}$ related math

17. Altitude of an aeroplane, pressure, temperature and velocity given. Find the pressure acting on the nose of the plane.

18. Graph of otto cycle efficiency vs compression ratio. Also show the specific heat ratio on it.



19. Differential form of energy, momentum and continuity equation for 2D steady state in reservoir fluid.

Answer: Continuity equation

$$\left(u \frac{d\rho}{dx} + v \frac{d\rho}{dy}\right) + \left(\rho \frac{du}{dx} + \rho \frac{dv}{dy}\right) = 0$$

Momentum Equation

$$\frac{\partial P}{\partial x} = -\left(\rho u \frac{\partial u}{\partial x} + \rho v \frac{\partial u}{\partial y}\right) \text{ and } \frac{\partial P}{\partial y} = -\left(\rho u \frac{\partial v}{\partial x} + \rho v \frac{\partial v}{\partial y}\right)$$

Energy Equation

$$\rho c_v \left(u \frac{\partial T}{\partial x} + v \frac{\partial T}{\partial y}\right) = -\left(\frac{\partial q_x}{\partial x} + \frac{\partial q_y}{\partial y}\right) - T \left(\frac{\partial P}{\partial T}\right)_p \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y}\right)$$

20. Pilot tube related math**21. Transducer related math****22. Matching**

Somerfield No.	– Journal Bearing
Molding	– Foundry
Chain sprocket	– flexible coupling
Quick return mechanism	– shaper m/c
Gear cutting	– milling m/c

Bangladesh Agriculture Development Corporation (BADC)**Post: AE (Mechanical)****Time-4.00PM to 5.00 PM****Date:17.06.2016****Courtesy: Amit Shor &****Group Members ME JOB PREPARATION****১. উল্লাসিক শব্দের অর্থ কি?**

(ক) লম্বা নাক (খ) উদ্ধত (গ) উন্নত (ঘ) অপরিকল্পিত

২. অহর্নিশ শব্দের অর্থ কি?

(ক) অসহনীয় (খ) সারা রাত্রি (গ) অনবরত (ঘ) অপ্রতিরোধ্য

৩. সোপান শব্দের অর্থ কি?

(ক) মৃদু (খ) সিঁড়ি (গ) অতল (ঘ) আকাশ

৪. অয়োময় শব্দের অর্থ কি?

(ক) চোখের বালি (খ) চোখের মণি (গ) লৌহময় (ঘ) অন্ধকার

৫. কোন বানানটি শুদ্ধ?

(ক) শ্মশান (খ) শশ্মান (গ) শ্বশান (ঘ) শ্মশান

৬. কোন বানানটি শুদ্ধ?

(ক) কক্ষ্মিনকাল (খ) কক্ষিনকাল (গ) কক্ষিণকাল (ঘ) কক্ষিণকাল

৭. কোন বানানটি শুদ্ধ?

(ক) মাধ্যাকর্ষণ (খ) মধ্যাকর্ষণ (গ) মাধ্যাকর্ষন (ঘ) মধ্যাকর্ষন

৮. আদিখ্যেতা বাগধারাটির অর্থ কি?

(ক) দক্ষতা (খ) সুনামধন্য (গ) ভীতু (ঘ) ন্যাকামি

৯. রাবণের চিতা বাগধারাটির অর্থ কি?

(ক) চির অশান্তি (খ) বিরাট অগ্নিকুণ্ড (গ) নিভীক (ঘ) দ্রুতগতি

১০. তামার বিষ বাগধারাটির অর্থ কি?

(ক) গভীর আঘাত (খ) ধাতব পদার্থের আঘাত (গ) অর্থের কুপ্রভাব (ঘ) পুরানো ক্ষত

11. When Sagar..... me, I.....Cartoon (B) Has you ever played
on TV (C) have you ever played

(A) Calls/ Was watching

(B) called/ was watching

(C) Have called/was watching

(D) called/watch

Synonyms

17. Meager

(A) scanty

12. It has been raining ----- four days

(B) offensive

(A) Since

(C) tasty

(B) with

(D) darkness

(C) from

(D) For

13. I wish I the game this time

(A) win

(B) could won

(C) can win

(D) could win

14. The box of tissues ----- nearly empty

(A) was

(B) were

(C) has

(D) have

15. where coming from

(A) you are

(B) are you

(C) do you

(D) you do

16. football

(A) did you ever played

22. Faruk has x more marbles than sanwar has and together they have a total of y marbles . which of the following represents the number of marbles that sanwar has?

(A) $(y-x)/2$

(B) $y-x/2$

(C) $y/2-x$

(D) $2y-x$

23. if x books cost of TK 50 and y books cost of 80 each then the average cost in taka per book is equal to

(A) $(50x+80y)/xy$

(B) $(5x+8y)/(.1x+.1y)$

(C) $(50x+80y)/130$

(D) none of these

24. In a cases of 50 students 15 failed I maths, 15 failed in science and 2 failed in both subjects. How many students of the class passed in both math and science?

(A) 27

(B) 29

(C) 33

(D) none 25. if $a-b/3=1/3$ and $a+b/4=3/2$ then

(A) 2

18. Aggravate

(A) Accommodate

(B) acquire

(C) worsen

(D) harmony

19. Malice

(A) cruelty

(B) beauty

(C) compromise

(D) Massive

20. Futile

(A) Hard

(B) useless

(C) pervert

(D) furbish

21. if $b < 2$ and $2x-3b=0$ which of the following must be true?

(A) $x > 3$

(B) $x < 2$

(C) $X=3$

(D) $x < 3$

26. The coxt of x numbers of pens is equal to the cost of $(x+2)$ number of pencils. If per unit costs of pen and pencil are 10 and 8 Tk. Respectively, then $x=?$

(A) 4

(B) 6

(C) 8

(D) none

27. If $2x=3(x-2)$ then $6x+3=?$

(A) 0

(B) 6

(C) 39

(D) none

28. If n is the average (Arithmetic mean) of the three numbers 6, 9, and K . What is the value of K interms of N ?

(A) $3n-15$

(B) $n-5$

(C) $n-15$

(B) 3

(C) 4

(D) none

31. "World health day" is observed on-

(A) 1st December(B) 1st april(C) 7th December**(D) 7th April**

32. who among the following has won the FIFA Ballon D'or award for 2015?

(A) Lionel Messi

(B) Cristiano Ronaldo

(C) Franck Ribery

(D) Batistuta

33. The smallest country in the world is –

(A) Maldives

(B) Vatican City

(C) Bolivia

(D) Myanmar

34. Which Bangadeshi architect designed the Sears tower in chicago

(A) F.R khan

(B) Khaleed Ashraf

(C) Rafiq Azam

(D) Luis I khan

35. Which of the sea is also called the salt sea?

(A) Bay of bengal

(B) Persian gulf

(C) Caspian Sea

(D) Dead sea

36. The biggest desert of the world is-

(A) Great Victoria

(B) Sahara

(C) Kalahari

(D) Tabemas

37. Where is the head office of UNESCO situated

(A) Washinto D.C

(B) Vienna

49. Which part of the refrigerant system releases heat- Condenser

50. What type of compressor is used in

(D) (n-15)/3

29. If $n = 15 \times 28 \times 26$ which of the following is NOT an integer(A) $n/15$ (B) $n/21$ **(C) $n/32$**

(D) None of these

30. When n is divided by 8 the remainder is 5. Which of the following is NOT an even?

(A) $n+3$ (B) $n-3$ (C) $3n+1$ **(D) $5n+2$** **(C) Paris**

(D) New York

38. In which country "Elephant Pass" is situated

(A) Burundi

(B) Singapore

(C) Sri lanka

(D) Thailand

39. Which of the following minerals is found at Madyapara In dinajpur district?

(A) Coal

(B) White Clay

(C) Lime stone

(D) Hard rock

40. The country most affected by Zika Virus is

(A) Canada

(B) Brazil

(C) Nigeria

(D) Ghana

41. $1 \text{ TR} = 3.521 \text{ KW}$

42. Break line is used in which view- Isometric drawing

43. Reynolds number is the ratio of inertia force and- viscous force

44. In which law temperature remains constant- Boyle's law

45. Reciprocating motion is converted into rotary motion when it is connected with- Crank shaft

airplane-? Axial compressor and centrifugal

51. Fluctuation above and below the mean speed is known as-

52. In which stroke valve open 30 degree before at top dead centre and 50 degree before the bottom dead center- Expansion stroke

53. Which one is correct for pelton wheel- high head, low flow rate .

54. Two parallel and coplanar shaft are connecting by gears having teeth parallel – spur gear

55. If the diameter of a pipe increases 2 times then what will be the flow velocity-

56. A four stroke flywheel controls- speed

57. For the same temperature and pressure which have better thermal efficiency-

58. when dry bulb and wet bulb temperature equals-

59. when bending moment becomes maximum-

60. Which one is boiler accessories- Economiser

61. Air preheater situates between – Economiser and chimney

46. F.H.P= I.H.P- B.H.P

47. Relation between C_p and C_v - $C_p > C_v$

48. Long and short column is determined by – Slenderness ratio

62. Relation between power and COP in refrigeration cycle- Inverse

63. Binary cycle mainly-

64. Which type of boiler is perfect for high generation at low pressure- Lancashire boiler

65. Moment of inertia of solid body-

66. Kelvin-planck states that- heat energy into work

67. Which type of compressor /pump is used to lift crude oil- positive displacement pump

68. Knocking-

69. In centrifugal compressor fluid flows- perpendicular

Sonali Bank (Bankers' Selection Committee Secretariat)**Post: Assistant Engineer(Mechanical)****Time: 17 June,2016; 10A.M.-11A.M.****Exam Hall: AUST****Thanks To – Amit Shor & R Z Chowdhury**

Marks: Bangla (10)+English(10)+Math(20)= 40

Departmental- 60

1. The maximum frictional force which comes into play when a body just begins to slide over the surface of the other body is known as
a) Static friction b) Dynamic friction **c) Limiting friction** d) Co-efficient friction
2. A self-locking machine efficiency –
a) Less than 50% b) Greater than 50% c) Equal to 50% d) None of these
3. If tension in the cable supporting a lift moving downwards is half the tension when it is moving upwards, the acceleration of the lift is –
a) $9/2$ b) $9/3$ c) $9/4$ **d) None of these**
4. The energy stored in a body when strained within elastic limit is known as
a) Resilience b) Proof resilience **c) Strain energy** d) Impact energy
5. The strain energy stored in a spring when subjected to maximum load without suffering permanent distortion is known as-
a) Impact energy **b) Proof resilience** c) Proof stress d) Modulus of resilience
6. When a load on the free end of a cantilever beam is increased, failure will occur-
a) At the free end **b) At the fixed end** c) In the middle of the beam d) At a distance $2l/3$ from free end
7. A pressure vessel is said to be a thick shell, when-
a) It is made of thick sheets
b) The internal pressure is high
b) The ratio of wall thickness of the vessel to its diameter is less than $1/10$
c) The ratio of wall thickness of the vessel to its diameter is greater than $1/10$
8. The Rankine formula holds good for
a) Short column b) Long column **c) Both short & long column** d) Weak column
9. If the depth of water in an open channel is greater than the critical depth the flow is called
a) Critical flow b) Turbulent flow c) Tranquil flow **d) Torrential flow**
10. The impeller of a centrifugal pump may have
a) Volute casing b) Volute casing with guide mechanism c) Vortex casing **d) Any of these**
11. Which of the following pump is used to pump highly viscous fluid
a) Centrifugal pump b) Reciprocating pump c) Air lift pump **d) Screw pump**
12. The fittings mounted on the boiler for its proper and safe functioning is a
a) Water level indicator b) Pressure gauge c) Safety valve d) Fusible plug

Note: It contains all the correct options.

13. The efficiency of a steam turbine may be improved by-
a) Reheating of steam b) Regenerative feed heating c) Binary vapor plant d) **Any one of these**
14. The thermal efficiency of a petrol engine is almost
a) **30%** b) 40% c) 50% d) 60%
15. A moderator is generally used in a nuclear power plant is
a) Graphite b) Heavy water c) Concrete d) **Graphite & concrete**
16. The overall co-efficient of heat transfer is used in problems of
a) Conduction b) Convection c) Radiation d) **Conduction & convection**
17. One ton of refrigeration (1 TR) means that the heat removing capacity is
a) 5 Kcal/min b) **50 Kcal/min** c) 100 Kcal/min d) 150 Kcal/min
18. The considerable property of a refrigerant is
a) Non-toxic b) Non-flammable c) Non-explosive d) **High boiling point**
19. The total number of instantaneous centers for a mechanism consisting of n links are
a) $n/2$ b) n c) $n-1$ d) **$n(n-1)/2$**
20. V belts are normally used for-
a) Long drive b) **Short drive** c) Short & long drive d) None of these
21. The size of a gear is normally specified by-
a) Pressure angle b) Circular pitch c) Diametral pitch d) **Pitch circle diameter**
22. The minimum number of teeth on the pinion which will mesh with any gear without interference for 20 degree full depth involute teeth will be
a) 12 b) 14 c) **18** d) 24
23. The helix angle for single helical gears ranges from
a) 10 to 15 b) 15 to 20 c) **20 to 35** d) 35 to 50
24. Ball bearings are usually made from
a) Low carbon steel b) High speed steel c) High carbon steel d) **Chrome steel**
25. In a centrifugal casting method
a) Core is made of sand b) Core is made of ferrous metal c) Core is made of non-ferrous metal d) **No core is used**
26. Drilling is an example of
a) Orthogonal cutting b) **Oblique cutting** c) Simple cutting d) Uniform cutting
27. The process of removing metal by a cutter which is related against the direction of travel of work piece is called
a) **Up milling** b) Down milling c) Face milling d) End milling
28. The efficiency of Joule cycle is
a) Greater than Carnot cycle b) **Less than Carnot cycle** c) Equal to Carnot cycle d) None of these
29. The gas in cooling chamber of a closed cycle gas turbine is cooled at-
a) Constant volume b) Constant temperature c) **Constant pressure** d) None of these
30. The fuel mostly used in cement industry and metallurgical process is-
a) Wood charcoal b) Bituminous coke c) **Pulverised coal** d) Coke

31. The selection of type and size of a steam boiler depends upon-
- The power required & working pressure
 - The geographical position of the power house
 - Fuel and water availability
 - All of these**
32. A spring used to absorb shocks and vibrations is
- Conical spring
 - torsion spring
 - leaf spring**
 - disc spring
33. The columns whose slenderness ratio is less than 80, are known as
- Short column**
 - long column
 - weak columns
 - medium columns
34. The stress developed in the material without any permanent set is called
- Elastic limit**
 - yield stress
 - ultimate stress
 - breaking stress
35. The cavitation in a hydraulic machine is mainly due to
- Low velocity
 - high velocity
 - low pressure**
 - high pressure
36. The process used for relieving the internal stresses previously set up in the metal and for increasing the machinability of steel, is
- Normalizing
 - full annealing
 - process annealing**
 - sheroidizing

**West Zone Power Distribution Company Limited
Recruitment Test-2014**

Date: 28/02/2014, Venue: KUET

1. Write down four differences between SI & CI engine.

SI Engine	CI Engine
1. It is an engine in which the spark is used to burn the fuel.	1. It is an engine in which heat of compressed air is used to burn the fuel.
2. Petrol is used as fuel.	2. Diesel is used as fuel.
3. It operates on Otto cycle.	3. It operates on Diesel cycle.
4. Low compression ratio.	4. High compression ratio.
5. High thermal efficiency.	5. Less thermal efficiency.
6. Spark plug is used to produce spark for the ignition.	6. Heat of compressed air is used for the ignition.

2. Write down four differences between Shaper & Planer machine.

Shaper	Planer
1. A Shaper is traditionally a small machine and preferred for smaller jobs.	1. A planer is a larger machine and can accommodate heavier and larger jobs. Jobs as large as 7 meter wide and twice as long can be machined on a Planer.
2. In a shaper, machine work is held stationary and the cutting tool on the ram is moved back and forth across the	2. In a planer machine, the tool is stationary and work piece travels back and forth under the tool

work.	
3. The Shaper Machine uses Quick Return Motion Mechanism to drive the ram.	3. The Planer Machine is driven by means of gear or hydraulic arrangement.
4. Shaper Machine uses a single-point cutting tool for the operation.	4. Planer Machine also uses a single-point cutting tool for the operation and more than one tool also can be used.

3. Write down the ways of increasing efficiency of Gas Turbine.

Efforts to improve the cycle efficiency are concentrated in three areas:

1. Increasing the turbine inlet (or firing) temperature: The turbine inlet temperatures have increased steadily from about 540°C (1000°F) in the 1940s to 1425°C (2600°F) and even higher today.

2. Increasing the efficiencies of turbo-machinery components (turbines, compressors): The advent of computers and advanced techniques for computer-aided design made it possible to design these components aerodynamically with minimal losses.

3. Adding modifications to the basic cycle (intercooling, regeneration or recuperation, and reheating): The simple-cycle efficiencies of early gas turbines were practically doubled by incorporating intercooling, regeneration (or recuperation), and reheating.

4. Write down four advantages of Gas Turbine over IC engine.

Answer: (i) Increased reliability.

(ii) longer mean times between overhaul.

(iii) higher airspeeds.

(iv) Ease of operation at high altitudes.

(v) high power to engine weight ratio.

5. What is carburizing?

Answer: Carburizing is a case-hardening process by which carbon is added to the surface of low-carbon steel. This results in carburized steel that has a high-carbon surface and a low-carbon interior. When the carburized steel is heat-treated, the case becomes hardened and the core remains soft and tough.

6. What is plant capacity factor and diversity factor?

Answer:

Plant capacity factor: It is the ratio of actual energy produced to the maximum possible energy that could have been produced during a given period i.e.

Plant capacity factor = Actual energy produced/ Max. energy that could have been produced

= Average demand × T/ Plant capacity × T

= Average demand/ Plant capacity

Thus if the considered period is one year,

Annual plant capacity factor = Annual kWh output/Plant capacity × 8760

Diversity factor: The ratio of the sum of individual maximum demands to the maximum demand on power station is known as diversity factor i.e.

Diversity factor = Sum of individual max. demands/Max. demand on power station.

7. Write down four major operations done by Lathe machine.

Answer: Same as question-8 of Bangladesh Bank 2019

8. What are the functions of (a) Hydrometer (b) Psychrometer (c) Rota meter (d) Anemometer.

Answer: (a) Hydrometer: A hydrometer is an instrument used to determine specific gravity. It operates based on the Archimedes principle that a solid body displaces its own weight within a liquid in which it floats. Hydrometers can be divided into two general classes: liquids heavier than water and liquids lighter than water.

(b) Psychrometer: A psychrometer or sling psychrometer is used to measure measures relative humidity or how much water is in the air. Two thermometers, one wrapped in wet material and the other dry, are placed next to each other. As the wet thermometer is dried off evaporative cooling happens. The measurement of the temperature difference between the two thermometers provides the dew point and relative humidity.

(c) Rota meter: A device used to measure fluid flow, in which a float rises in a tapered vertical tube to a height dependent on the rate of flow through the tube. It is a variable area meter which works on the principle of upthrust force exerted by fluid and force of gravity.

(d) Anemometer: An anemometer is an instrument that measures wind speed. This type of anemometer has a spinning wheel. The stronger the wind blows, the faster the wheel rotates. The anemometer counts the number of rotations, which is used to calculate wind speed.

9. Write down the functions of governor and flywheel.

Governor: A governor, or speed limiter or controller, is a device used to measure and regulate the speed of a machine, such as an engine. To regulate the mean speed of an engine, when there are variations in the load e.g. when the load on an engine increases, its speed decreases, therefore it becomes necessary to increase the supply of working fluid.

Flywheel: A flywheel is a mechanical device specifically designed to efficiently store rotational energy. Its resist changes in rotational speed by their moment of inertia. A flywheel is nothing but a heavy rotating disc attached to a shaft. It rotates along with the shaft. The flywheel only reduces the fluctuation of speed. It does not maintain the constant speed. The flywheel cannot be used to regulate the speed variation caused by the varying load.

10. What are the functions of Management?

Answer: Basic functions of management are planning, organizing, staffing, directing and controlling.

11. Write down four methods of Power Transmission.

Answer: Belt Drive, Rope Drive, Chain Drive and Gear Drive.

12. How to transfer power from engine to wheel in Automobile?

Answer: Different types of automobile has different transmission system.
Engine→Clutch→Gear box→propeller shaft→Differential→Half shafts.

or

Engine →Clutch→Gear train→propeller shaft→Differential→Rear axle→rear wheels.
The above power flow is for Front engine rear wheel drive .

13. Write down various types of power plant present in Bangladesh.

Answer: (a) Combined cycle power plant, (b) Gas turbine based, (c) Engine (gas, diesel, HFO) based, (d) Steam turbine power plant, (e) Hydro power plant, (f) Coal based power plant, (g) HSD based power plant, (i) Solar based power plant.

14. Why does need to govern Steam Turbine?

Answer: Steam turbine governing is the procedure of controlling the flow rate of steam into a steam turbine so as to maintain its speed of rotation as constant. The variation in load during the operation of a steam turbine can have a significant impact on its performance. In a practical situation the load frequently varies from the designed or economic load and thus there always exists a considerable deviation from the desired performance of the turbine. The primary objective in the steam turbine operation is to maintain a constant speed of rotation irrespective of the varying load. This can be achieved by means of governing in a steam turbine.

15. What is tone of Refrigeration?

Answer: Discussed at previous year Job solutions.

16. What is priming? Why it is necessary?

Answer: Priming of a centrifugal pump is defined as the operation in which the suction pipe, casing of the pump and a portion of the delivery pipe upto the delivery valve is completely filled up from outside source with the liquid to be raised by the pump before starting the pump. Thus the air from these parts of the pump is removed and these parts are filled with the liquid to be pumped. When the pump is running in air, the head generated is in terms of metre of air. If the pump is primed with water, the head generated is same metre of water. But as the density of air is very low, the generated head of air in terms of equivalent metre of water head is negligible and hence the water may not be sucked from the pump. To avoid this difficulty, priming is necessary.

Titas Gas Transmission and Distribution Company Limited-2008

Venue: MIST

1. What is Nusselts Number?

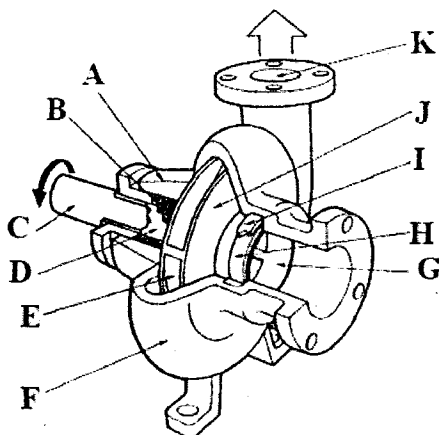
Answer: Page-9, North West Power Generation Company Limited (NWPGL)-2015

2. What is Centrifugal pump and write the different parts of the Centrifugal pump.

Answer: If the mechanical energy is converted into pressure energy by means of centrifugal force acting on fluid, the hydraulic machine is called centrifugal pump.

The centrifugal pump acts as a reversed of an inward radial flow reaction turbine.

Main parts of centrifugal pump:



- A- Stuffing Box
- B- Packing
- C- Shaft
- D- Shaft Sleeve
- E- Vane
- F- Casing
- G- eye of Impeller
- H- Impeller
- I- Casing wear ring
- J- Impeller
- K- Discharge nozzle

3. Write the second Law of Thermodynamics with Example.

Answer: Question-1, West Zone Power Distribution Company Ltd. (WZPDCL)-2016

Example: Refrigerator, heat pump etc.

4. What is Carnot Cycle?

Answer: The best known reversible cycle is the Carnot cycle. The Carnot cycle is composed of four reversible processes (two isothermal and two adiabatic) and it can be executed either in a closed or a steady-flow system.

- 1-2 Reversible isothermal expansion
- 2-3 Reversible adiabatic expansion
- 3-4 Reversible isothermal compression
- 4-1 Reversible adiabatic compression

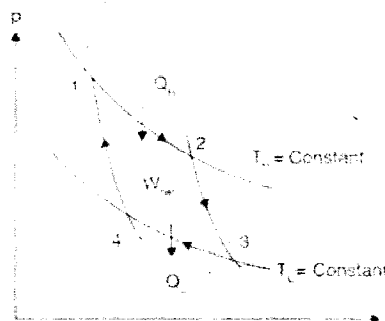


Fig.: P-V Diagram of Carnot Cycle

5. What is closed cycle Gas turbine and draw the, P-V diagram and T-S Diagram of Closed cycle gas turbine?

Answer: Question-45, B-R Powergen Ltd-2019

6. What is VVTI?

Answer: VVT-I (Variable valve timing with intelligence):

VVT-I is an automobile variable valve timing technology developed by Toyota. It varies the timing of the intake valves by adjusting the relationship between the camshaft drive (belt or chain) and intake camshaft.

7. What is Reynolds Number? What is the significant of Reynolds Number?

Answer: Question-24, North West Power Generation Company Limited (NWPGL)-2015

8. Difference between pump, compressor, blower and fan.

Answer: Same as Question 5, West Zone Power Distribution Company Ltd. (WZPDCL)-2016

9. What is volumetric efficiency?

Answer: Volumetric Efficiency: It is the ratio of the volume of air inducted at ambient conditions to the swept volume of the engine.

$$\eta_v = \frac{\text{Volume of charge aspirated per stroke at ambient conditions}}{\text{Stroke volume}}$$

10. What is Ton of Refrigeration?

Answer: Discussed at previous year Job solutions.

Dhaka Water Supply And Sewerage Authority-2008

1. Find highest possible theoretical efficiency of heat engine, the temp of heat reservoir is 2100° C and cooling water 15° C.

Solution:

$$\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{15+273}{2100+273} = 87.86\% \text{ (Answer)}$$

2. A compressor air tank volume 0.84m³. Fill with air gauge pressure 50KPa. Find the density & weight of air, assume the temperature of air 30°C and atmospheric pressure 101KPa.

Solution:

Absolute pressure, $P = 101 + 50 = 151\text{KPa}$, $T = 30 + 273 = 303\text{K}$, $V = 0.84\text{m}^3$

$$\text{We get, } \rho = \frac{P}{RT} = \frac{151 \times 1000}{287 \times 303} = 1.736\text{kg/m}^3$$

Weight of air, $m = \rho V = 1.736 \times 0.84 = 1.458\text{kg}$ (Answer)

3. Why air vessel is used in reciprocating pump.

Answer: The vessels are used for the following purposes:

(a) To get continuous supply of liquid at a uniform rate.

(b) To save the power required to drive the pump. This is due to the fact that by using air vessels, the acceleration and friction heads are reduced. Thus the work is also reduced.

4. A tube filled with a fluid of sp. Gravity 0.9, depth 120cm. Find the pressure at the depth in kw/m².

Solution: We get,

$$P = \rho gh = 0.9 \times 1000 \times 9.81 \times 1.2 = 10594.8\text{Pa (Answer)}$$

5. Why priming is need in centrifugal pump?**6. Draw Otto cycle in P-V & T-S diagram.****7. Draw a characteristic curve of centrifugal pump.**

8. Describe the process of cooling & dehumidification in psychometric chart / Air conditioning system.

9. In vapor-compression refrigeration cycle draw T-s and p-h diagram.

[Answer of the questions 5,6,7,8 & 9 are already discussed in other exam solutions]

Bangladesh Sugar & Food Industries Corporation-2008

1. Define water tube and fire tube boiler.

2. Difference between sensible heat and latent heat.

Answer:

Sensible Heat: Sensible heat is the energy transferred as heat that will change the temperature of a substance with no change of phase. The sensible heat of a thermodynamic process may be calculated by the equation-

$Q_{\text{sensible}} = ms\Delta T$; Where, m = body's mass; s = specific heat capacity and ΔT = change in Temperature.

Latent Heat: The heat which brings about a change of state with no change in temperature is called latent heat. For ice melting 335 KJ/kg and For vaporization 2257 KJ/kg

3. Difference between shaper & planner machine.

Answer: Question-2, West Zone Power Distribution Company Limited-2014

4. Convert 1kg/cm^2 to lb/ft^2 .

Solution: $1\text{kg/cm}^2 = 2048.2 \text{ lb/ft}^2$

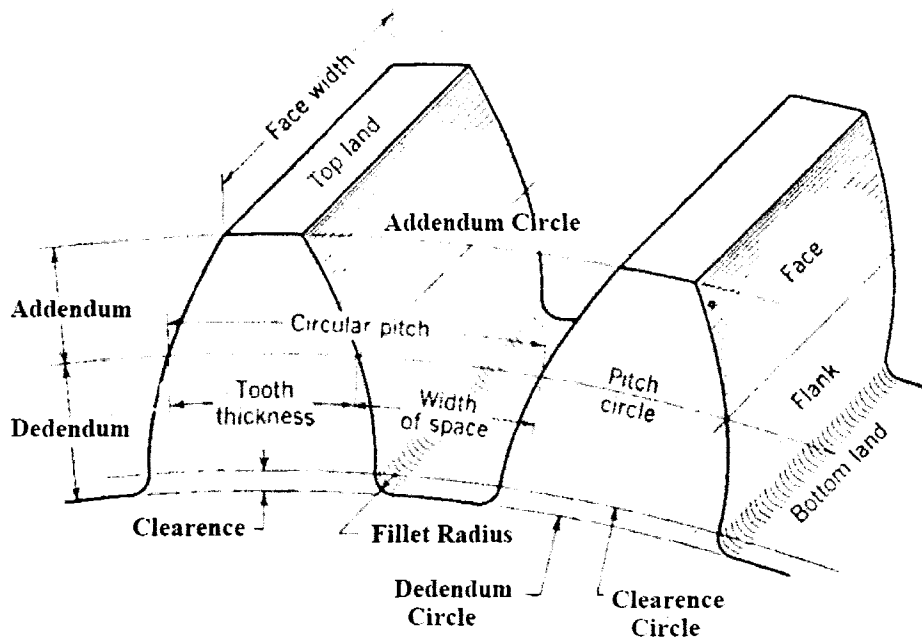
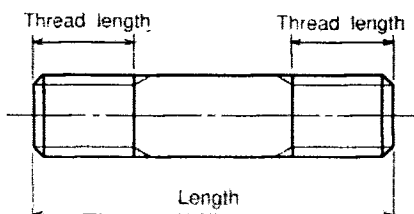
5. Difference between impulse & reaction turbine.

Answer:

Impulse Turbine	Reaction Turbine
In an impulse turbine, the steam flows through the nozzle and strike on the moving blades.	In the reaction turbine, first, the steam flows through the guide mechanism and then flows through the moving blades.
Steam strikes on the buckets with kinetic energy.	The steam glides over the moving blades with both pressure and kinetic energy.
During the flow of steam through moving blades, its pressure remains constant.	During the flow of steam through moving blades its pressure reduces.
The steam may or may not be admitted to the whole circumference.	The steam must be admitted over the whole circumference.
The blades of impulse turbine are symmetrical.	The blades of reaction turbine are not symmetrical.
While gliding over the blades the relative velocity of steam remains constant.	In reaction turbine, while gliding over the blades the relative velocity of steam increases.
For the same power developed, the number of stages required is less.	For the same power developed, the number of stages required is more.
The direction of steam flow is radial to the direction of turbine wheel.	The direction of steam flow is radial and axial to the turbine wheel.
It requires less maintenance work.	It requires more maintenance work.
It is suitable for low discharge.	It is suitable for medium and high discharge.
Pelton Wheel is the example of impulse turbine.	Francis turbine, Kaplan turbine etc. are the examples of reaction turbine.

6. Difference between motor and generator.**Answer:**

Motor	Generator
1. Electric motors convert electrical energy into mechanical energy.	1. Generators convert mechanical energy into electrical energy.
2. Flemings' left-hand rule is followed to know the direction of motion.	2. Fleming's right-hand rule is followed to know the direction of produced electricity.
3. In motors, the current has to supply to armature windings.	3. In generators armature windings produce current.
4. The electric motor gives outback emf to the circuit.	4. The generator gives emf to the load connected.
5. Application: Automobiles, elevators, fans, pumps, etc.	5. Application: In power supply chains in industries, testing purposes in the laboratory, general lighting, powering of batteries, etc.

7. Draw a gear and specify addendum & dedendum.**Answer:****8. Draw a stud bolt & specify them.**

9. Write the meanings- RAM, BITAC, ICDDR, WTO and ANZUS.

Answer:

RAM- Random Access Memory

BITAC- Bangladesh Industrial Technical Assistance Center

ICDDR- International Centre for Diarrheal Disease Research, Bangladesh

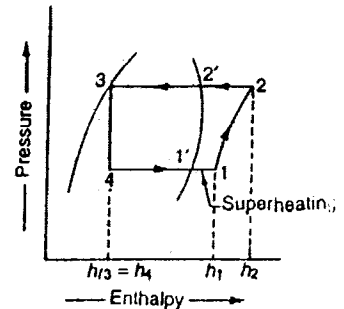
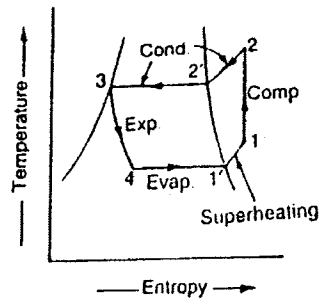
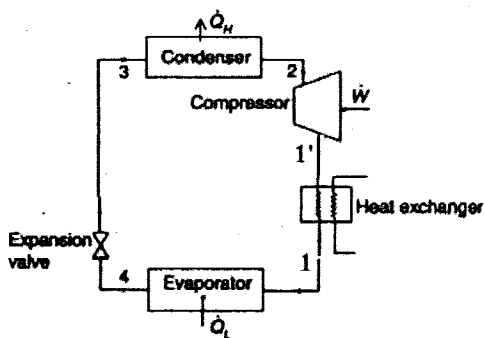
WTO- World Trade Organization

ANZUS- The Australia, New Zealand and United States Security Treaty (agreement signed in 1951 to protect the security of the pacific)

Bangladesh Water Development Board (BWDB)- 2008

1. Draw a block diagram & p-h diagram of vapor-compression refrigeration cycle with reheating but not sub cooling.

Answer:



2. Draw a p-v & T-S diagram of diesel engine.

3. Draw a stress-strain diagram for mild steel.

4. KW/Ton=3.5/COP. Find Power in watt.

[Already discussed]

5. A spring deflection 10mm & the stiffness constant 50 kN/m. Find the force.

Solution: $F = \delta x$

$\Rightarrow F = 50 \times 0.01 = 0.5 \text{ kN (Answer)}$

6. Given discharge = $20 \text{ m}^3/\text{sec}$. Head = 30m, motor efficiency = 90%. Find power in KW.

7. At the same speed rpm = which is the maximum torque produced a hollow shaft ($D_o = 2D_i$) and a solid shaft. Prove that.....

[6,7 has insufficient data]

River Research Institute-2008

1. Draw p-v diagram of Otto & diesel cycle.

2. What is the function of economizer & safety valve?

Answer: Question-8, Power Development Board (PDB)-2010

3. Define cop of refrigeration & higher heating value.

Answer: Higher Heating/calorific value: Higher calorific value of a fuel portion is defined as the amount of heat evolved when a unit weight (or volume in the case of gaseous fuels) of the fuel is completely burnt and the products of combustion cooled to the normal conditions (with water vapor condensed as a result).

4. Write a 2nd law of thermodynamics.

5. Draw a characteristics curve of centrifugal pump.

6. Write a Bernoulli equation for ideal & real fluid.

7. Draw stress strain diagram for ductile material.

8. A point load applied on the middle of the simply supported beam. Draw SFD & BMD. Find their maximum value.

[All other questions are discussed in other job exam solutions]

Bangladesh Export Processing Zones Authority-2008

1. Define boiler. What is the difference between water and fire tube boiler.

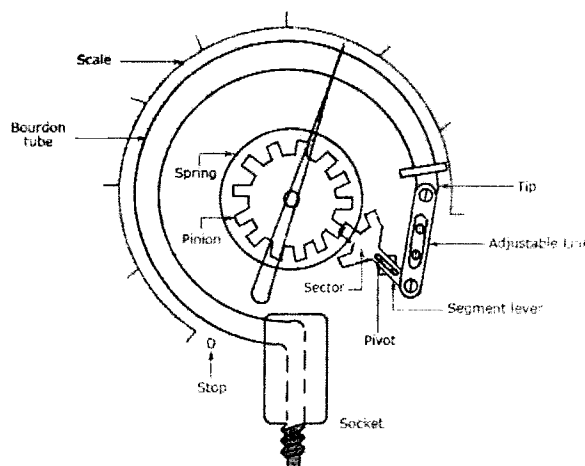
Answer: A steam generator or boiler is usually a closed vessel made of steel. Its function is to transfer the heat produced by the combustion of fuel to water and ultimately to generate steam. [Rest part of the question is discussed at others job solution]

2. Write a short note: pressure gauge, fuel pump, spark plug, fuel pump and condenser.

Answer:

Pressure Gauge:

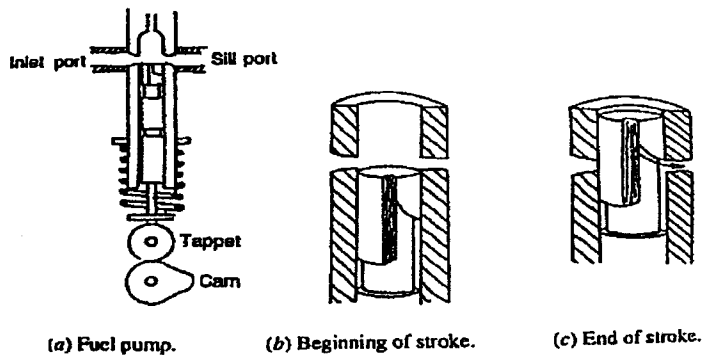
Pressure gauge is the instrument for measuring the condition of a fluid (liquid or gas) that is specified by the force that the fluid would exert, when at rest, on a unit area. Gauge pressure is the pressure above the atmospheric pressure. $P_{\text{gauge}} = P_{\text{absolute}} - P_{\text{atmospheric}}$. Bourdon tube pressure gauges are the most common type in many areas and are used to measure medium to high pressures. They cover measuring spans from 600 mbar to 4,000 bar. The measuring element is a curved tube with a circular, spiral or coiled shape, commonly called a bourdon tube.



Bourdon Tube Pressure Gauge

Fuel pump: The main object of a fuel pump in a diesel engine is to deliver a fuel to the injector which sprays the finely divided particles of the suitable for rapid combustion. The simplified of a fuel pump is shown in Fig.(a). It consists of a plunger which moves up and down in the barrel by the cam and spring arrangement provided for pushing and lowering the plunger respectively. The fuel oil is highly filtered by means of felt-pack filter before entering the barrel of the pump.

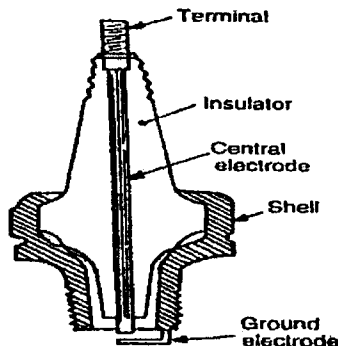
The upper end part of the plunger is cut away in a helix shaped piece forming a groove between the plunger and barrel, which is the most important one. Therefore, the amount of fuel delivered and injected into the engine cylinder depends upon the rotary position of the plunger in the barrel. Fig. (b) and (c) shows how the top part of the plunger is designed so that the correct amount of fuel is delivered to the injector.



When the plunger is at the bottom of its stroke as shown (b), the fuel enters the barrel through the port. As the plunger rises, it forces this fuel up into the injector, until the upper part cut away comes opposite the sill port. Then the fuel escapes down the groove and out through the sill port so that injection ceases, as shown in Fig. (c). The plunger can be made to rotate in the barrel and therefore more fuel is injected. When the plunger is rotated so that the groove is opposite to the sill port, no fuel at all is injected and thus the engine stops.

Spark plug:

It is always screwed into the cylinder head for igniting the charge of petrol engines. It is usually, design to with stand a pressure up to 35 bars and operate under a current of 10000 to 30000 volts. A spark plug consists of central porcelain insulator containing an axial electrode length wise and ground electrode welded to it. The central electrode has an external contact at the top.



Dual Fuel:

The dual-fuel engine works on diesel cycle. The gaseous fuel (the primary fuel) is added to the air inducted by the engine or supplied by the supercharger at a pressure slightly above the atmospheric pressure. This mixture of air and gaseous fuel is compressed in the cylinder just like air in normal diesel operation. At some point in the compression stroke, near top dead center, a small charge of liquid fuel called pilot fuel (or the secondary fuel) is injected through a conventional diesel fuel system. This pilot acts as a source of ignition the gas-air mixture in the vicinity of the injected spray ignites at a number of flame-fronts. Thus combustion starts smoothly and rapidly.

3. Define fuel. List the merits and demerits of liquid fuel over solid fuel.

Fuel: A fuel is defined as any substance used to produce heat or power by combustion. Any chemical process accompanied by the evolution of light and heat is called combustion. It is simply the reaction of substances with oxygen and converts chemical energy into heat and light.

Following are the merits and demerits of liquid fuels over Solid Fuel:

Merits: 1. Higher Calorific value. 2. Lower storage capacity required. 3. Better economy in handling. 4. Better control of consumption by using valves. 5. Practically no ashes. 6. Non-deterioration in storage. 7. Non-corrosion of boiler plants. 8. Higher efficiency.

Demerits: 1. Higher cost 2. Greater risk of fire. 3. Costly containers are required for storage and transport.

4. What is the difference between petrol & diesel fuel?**Answer:**

1. Petrol is made of a mix of alkanes and cycloalkanes with a chain length of between 5-12 carbon atoms. These boil between 40°C and 205°C. Gas oil or Diesel is made alkanes containing 12 or more carbon atoms. These have a boiling point between 250°C and 350°C.
2. Per litre, diesel contains more energy than petrol and the vehicle's engine combustion process is more efficient, adding up to higher fuel efficiency and lower CO₂ emissions when using diesel.

5. What is the cooling system of I.C. engine? What is the difference between air cooling and water cooling?

Answer: An IC engine cooling system is the supply and collection of coolants which sole purpose is to remove the excess heat from the engine and maintain the engine's temperature at optimal levels. Comprising many different components such as water pump, coolant, a thermostat etc. the system enables smooth and efficient functioning of the engine at the same time protecting it from damage.

Air Cooling system	Water Cooling System
1. The design of this system is simple and less costly.	1. The design of this system is complicated and more costly.
2. The weight of the cooling system per BHP of the engine is very less.	2. The weight of the cooling system per BHP of the engine is much more.
3. The fuel consumption is more.	3. The fuel consumption is less.
4. Its installation and maintenance are very easy and less costly.	4. Its installation and maintenance are very difficult and more costly.

5. There is no danger of leakage or freezing of the coolant.	5. There is a danger of leakage or freezing of the coolant.
6. It works smoothly and continuously. Moreover, it does not depend on any coolant.	6. If it fails, the system may cause serious damage to the engine within a short time. CI

6. What is the difference between IC engine and SI engine?

Answer: Question-1, West Zone Power Distribution Company Limited

7. What is gas turbine? What is the difference between gas turbine and steam turbine?

Answer: The gas turbine is a rotating type prime mover which converts the heat energy of gas/air (at high pressure and temperature) into mechanical work. The principle of operation is based on Newton's Second Law of Motion. The motive power is obtained from the change in momentum of high-velocity jet impinge on curved blades of the turbine. A simple as turbine consists of: (i) compressor, (ii) combustion chamber, and (iii) turbine.

Gas Turbine	Steam Turbine
1. Gas turbine operates on Byrton or Joule cycle.	1. Steam turbine operates on Rankine cycle.
2. In the gas turbine, the compressor and combustion chamber are important components.	2. In the steam turbine, the steam boiler and accessories are important components.
3. Less space for installation is required.	3. More space for installation is required.
4. The mass of gas turbines per kW produced is less.	4. The mass of the steam turbine per kW produced is more.
5. With the changing load conditions, its control is easy.	5. Its control is difficult, with the changing load condition.
6. The starting of this turbine is easy and quick.	6. The starting of the steam turbine is not easy and takes a long time.

8. List advantage and disadvantage of 2 stroke cycle engine over 4 stroke cycle engine.

Answer: Question-1, প্রাসঙ্গিক টেকনিক্যাল (BPSC)

9. What is the efficiency of steam engine? What is the difference between mechanical efficiency & overall efficiency?

Answer: Efficiency of Steam Engine: Efficiency of steam engine is defined as the ratio of work done to the energy supplied to an engine. In this page, we will discuss different efficiency of steam engine and efficiency calculation of steam engine.

Mechanical Efficiency: Mechanical efficiency of steam engine is the ratio of brake power (B.P.) to the indicated power (I.P.). It is expressed as: $\eta_m = \frac{BP}{IP}$

Overall Efficiency: Overall efficiency of steam engine is the ratio of the work obtained at the crank shaft in a given time to the energy supplied by fuel during the same time.

Let, m_f = Mass of fuel burnt in kg per hour, and

C = Calorific value of fuel in kJ/kg of fuel.

$$\eta_m = \frac{BP \times 3600}{m_f \times C}$$

Bangladesh Army-2008**1. Comparison between work and heat.**

Answer:

- Heat is energy interaction due to temperature difference. Work is energy interaction by reasons other than temperature difference.
- Heat is low grade energy while work is high grade energy.
- Heat is function of state because it is depend on state of system while work is function of path because it is depend on path taken by system while changing state.
- Efficiency of transfer of work to heat is higher but efficiency of transfer of heat to work.

2. Comparison between Quenching and Annealing.

Answer: Annealing consists of heating a metal to a specific temperature, holding it at that temperature for a set length of time, and then cooling the metal to room temperature. The cooling method depends on the metal and the properties desired. Some metals are furnace-cooled, and others are cooled by burying them in ashes, lime, or other insulating materials.

Quenching is the procedure used for cooling metal rapidly in oil, water, brine, or some other medium. Because most metals are cooled rapidly during the hardening process, quenching is usually associated with hardening; however, quenching does not always result in an increase in hardness; for example, to anneal copper, you usually quench it in water. Other metals, such as air-hardened steels, are cooled at a relatively slow rate for hardening.

3. Draw T-S diagram for SI engine.**4. Comparison between clutch and coupling.**

Answer:

A clutch is a mechanical device which engages and disengages power transmission especially from driving shaft to driven shaft. In these devices, one shaft is typically attached to an engine or other power unit (the driving member), while the other shaft (the driven member) provides output power for work. So, clutch provides a temporary connection between driver and driven shaft.

A coupling is a device used to connect two shafts together at their ends for the purpose of transmitting power. Couplings do not normally allow disconnection of shafts during operation, however there are torque limiting couplings which can slip or disconnect when some torque limit is exceeded. Coupling provides a permanent connection between the two shafts.

5. Comparison between SI and CI engine.**6. In a synchronize machine no of pole = 4 & frequency = 50 Hz, what will be speed?**

Solution: $N = \frac{120f}{P} = \frac{120 \times 50}{4} = 1500 \text{ rpm (Answer)}$

7. What is impulse and reaction turbine?

Answer:

Impulse Turbine: In an impulse turbine, the steam flows through the nozzle and strike on the moving blades. In an impulse turbine, the steam flows through the nozzle and strike on the moving blades. Steam strikes on the buckets with kinetic energy. During the flow of steam through moving blades, its pressure remains constant.

Reaction Turbine: In the reaction turbine, first, the steam flows through the guide mechanism and then flows through the moving blades. The steam glides over the moving blades with both pressure and kinetic energy. During the flow of steam through moving blades its pressure reduces.

8. What is cetane & Octane Number?

Octane Number: Octane number is defined as the percentage, by volume, of iso-octane in the mixture of iso-octane and n-heptane. It is the measure of rating of SI engine.

Cetane Number: Cetane number is defined as the percentage, by volume, of n-cetane in the mixture of n-cetane and alpha methyl naphthalene. It is the measure of rating of CI engine.

9. Mention present requirement and production of electricity.

Answer: Please visit: www.bpdb.gov.bd because this information is changeable time to time.

10. Name boiler accessories.

Answer: Already discussed in several job solution.

Bangladesh Air Force- 08

1. Motion of wheel is purely -----(**rotational**)
2. When two elastic bodies collide with other ----- all.
3. Euler column is valid for only -----(**long**) column.
4. In cantilever beam load is -----
5. Ductility of material---
6. Reynolds number= Inertia force/ Viscous force
7. A body is subjected to three mutually perpendicular stresses is known as Bulk modulus.
8. A perfect black body absorbs the radiations ----all wave length falling on it.
9. Stefan Boltzman formula related math.
10. 1 ton= 210 Kj/min
11. Bsfc related math
12. $Q = AV$ related math
13. Pitot tube related math
14. Reynolds Number related math
15. Shaft related problem with maximum shear stress theory.

Bangladesh Ordnance Factory (BOF)

Time: 2016

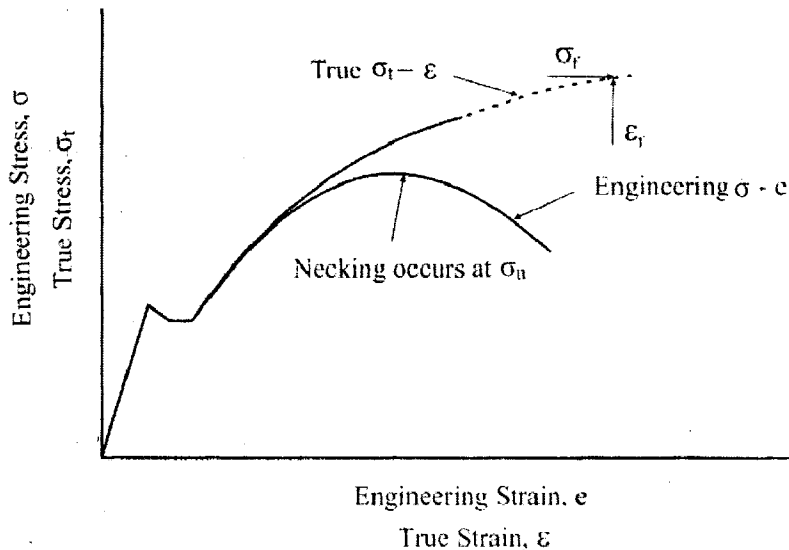
1. Write two statements of 2nd law of thermodynamics.
2. Write the differences between fan, blower and compressor.
3. Notes on: Octane and Cetane number.

[All questions are discussed already]

4. Difference between engineering and true stress strain diagram.

Answer: The difference between the engineering stress $\sigma = P/A_0$ and the true stress $\sigma_t = P/A$ becomes apparent in ductile materials after yield has started. While the engineering stress σ , which is directly proportional to the load P , decreases with P during the necking phase, the

true stress σ_t , which is proportional to P but also inversely proportional to A , keeps increasing until rupture of the specimen occurs.



5. Difference between fire and water tube boiler.

6. Why cavitation occurs in centrifugal pump but not in displacement pump.

Answer: Cavitation is production of vapor phase of liquid when the pressure within the flow goes so low it approaches vapor pressure.

So, it is 'boiling' of liquid due to immense pressure drop rather than heat addition considering the mechanism of formation, cavitation cannot happen just by low pressure (although that is a necessary condition). Inception of cavitation in a multi-component liquid at pressures near vapor pressure requires presence of nuclei which contain vapor, air or both. Cavitation occurs when these nuclei become unstable and aid to sudden localized flow instability. Since centrifugal pumps operation is based on use of hydrofoils, this phenomenon of unstable nuclei happens in this case only.

The major instability in centrifugal pumps can be due to one of the following causes:

- Too high flow velocity for a given geometry leading to extreme turbulence over hydrofoil
- Sharp edge hydrofoil (used to reduce drag but leads to early cavitation)
- Turbulent shear flow (flow itself turbulent)
- Other special cases like water entry cavity and bubble chambers.

No doubt, positive displacement pumps do have nuclei but they are stable. And there stability is not aggravated since no such events occur in positive displacement pumps.

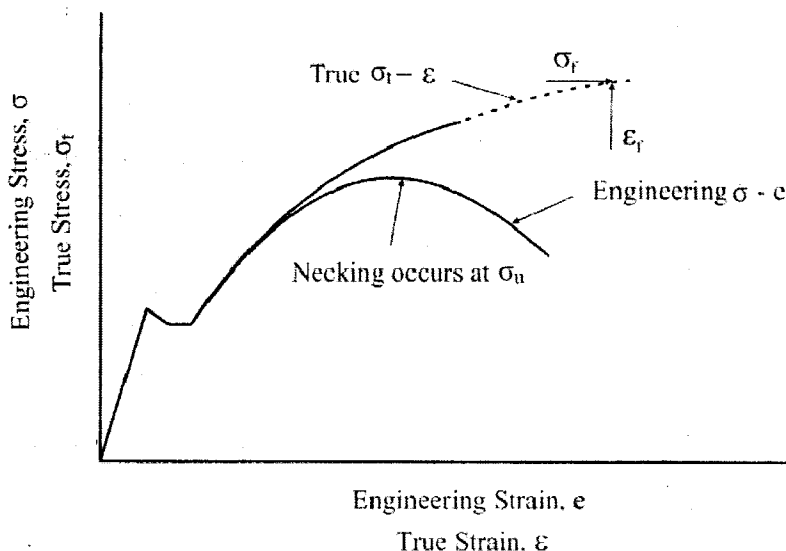
7. What is homogenous charge engine? Write the advantage and disadvantage of rotary engine over reciprocating engine.

Answer: HCCI is a form of internal combustion in which the fuel and air are compressed to the point of auto ignition. That means no spark is required to ignite the fuel/air mixture. It creates the same amount of power as a traditional engine, but uses less fuel.

Advantages:

1. higher revolutions per minute
2. a very few moving parts

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Advantages:

1. higher revolutions per minute
2. a very few moving parts

3. approximately 1/3rd of the size of the piston engine
4. weighs almost 1/3rd of the weight of the piston engines.
5. Vibration less engine
6. A high power rpm smooth with compact engine
7. Quiet running
8. Reliability
9. Better fuel economy

Disadvantages:

1. As unburnt fuel is in the exhaust stream, emissions requirements are difficult to meet.
2. The combustion is slow as the combustion chamber is long, thin, and moving.
3. As each section has temperature differences, the material expansion of housing is different at different region.
4. Poor fuel efficiency
5. Exhaust emissions
6. Manufacturing cost highest
7. Low compression ratio

8. Mohr's circle.

Answer: The transformation equations for plane stress can be represented in graphical form by a plot known as Mohr's Circle. This graphical representation is extremely useful because it enables us to visualize the relationships between the normal and shear stresses acting on various inclined planes at a point in a stressed body.

9. Explain: VTEC, EFI, ABS, DOHC, and ECM.

Answer: VTEC (Variable valve timing and lift electronic control): VTEC is a system developed by Honda to improve the volumetric efficiency of a four-stroke internal combustion engine. The VTEC system uses two camshaft profiles and hydraulically selects between profiles.

EFI (Electronic fuel injection): The Electronic Fuel Injection system fitted to most modern vehicles combines sophisticated computer controls with a high pressure fuel delivery system to provide optimum power and fuel efficiency.

ABS (Anti-lock braking system): (ABS) is an automobile safety system that allows the wheels on a motor vehicle to maintain tractive contact with the road surface according to driver inputs while braking, preventing the wheels from locking up (ceasing rotation) and avoiding uncontrolled skidding.

DOHC (Double overhead camshaft): A typical DOHC engine has two camshafts and 4 valves per cylinder. One camshaft operates intake valves that are installed on one side; while another camshaft controls exhaust valves on the opposite side. Most modern cars have DOHC engines.

ECM (Electronic Control module): Electronic control module is the computer responsible for providing fuel to the engine and controlling the quality of engine's emissions. The ECM uses a microprocessor and software to analyze and respond to the input values from an array of sensors.

(Including Bangla, English and General Knowledge)

DRY Dock Ctg.-2010

1. Draw the T-S diagram of reversible Rankine cycle.
2. Draw moment diagram
3. Draw a simple gear train with three gears.
4. What is LMFBR of nuclear power plant?

1. What is LMFBR of nuclear power plant?

A liquid metal fast breeder reactor (LMFBR) is a nuclear reactor capable of producing more fissile product than it takes in. Breeders exhibit remarkable fuel economy compared to light water reactors.

Liquid metal use in fast breeder reactors has long been considered for the improvement of efficiency in their heat transfer systems.

5. What is Bernoulli's equation?

According to Bernoulli's theorem, the sum of pressure energy, kinetic energy and potential energy per unit mass of an incompressible, non-viscous fluid in a streamlined flow remains constant. i.e. Pressure energy + kinetic energy + potential energy = constant

$$\frac{P}{\rho g} + \frac{V^2}{2g} + Z = \text{constant}$$

6. Abbreviation TIG, MIG, DSS, EDM, ILO, WHO, CBA.

TIG- Tungsten Inert Gas

MIG- Metal Inert Gas

DSS- Department of Social Security

EDM- Electronic Dance Music

ILO- International Labor Organization

WHO- World Health Organization

CBA- Commonwealth Broadcasting Association

7. What is nitriding process?

Nitriding is a heat treating process that diffuses nitrogen into the surface of a metal to create a case hardened surface. These processes are most commonly used on low carbon, low alloy steels. They are also used on medium and high carbon steels, titanium, aluminum and molybdenum.

8. List of different types of welding joint done at ships.

Butt joint, corner joint, tee joint, lap joint and edge joint.

9. Paragraph about "Safety Management".

Safety management is managing business activities and applying principles, framework, processes to help prevent accidents, injuries and to minimize other risk.

Safety management is commonly understood as applying a set of principles, framework, processes and measures to prevent accidents, injuries and other adverse consequences that may be caused by using a service or a product. It is that function which exists to assist managers in better discharging their responsibilities for operational system design and implementation through either the prediction of systems.

10. Heat transferred at a metal of 80 kg raised its temperature from 300 to 1265 K, specific heat of metal 0.49 KJ/kg K. What is the heat supplied?

Solution:

$$Q = mC_p\Delta T = 80 \times 0.49 \times (1265 - 300) = 37828 \text{ KJ}$$

11. Diameter of impeller is 80 mm. Jet velocity 20 m/s. What is exerted force by jet?

Solution:

$$F = \rho AV^2 = 1000 \times \frac{\pi}{4} (80 \times 10^{-3})^2 \times 20^2 = 2010.62 \text{ N}$$

12. Jet from nozzle at a velocity of 36 m/s. What is the velocity head?

$$\text{Solution: Velocity head} = \frac{V^2}{2g} = \frac{36^2}{2 \times 9.81} = 66.05 \text{ m}$$

13. Water delivered to service tank at rate of 1.15 m³/s from a reservoir 300 m above by a 3200 mm long pipe. What is the pipe diameter?

14. The piston of a steam engine moves with simple harmonic motion. The crank rotates at 120 r.p.m. with a stroke of 2 metres. Find the velocity of the piston, when it is at a distance of 0.75 metre from the centre.

Solution: Here, $N = 120$ r.p.m. or $\omega = 2\pi \times 120/60 = 4\pi$ rad/s ; $2r = 2$ m or $r = 1$ m ; $x = 0.75$ m
We know that velocity of the piston,

$$V = \omega \sqrt{r^2 - x^2} = 4\pi \sqrt{1^2 - 0.75^2} = 8.31 \text{ m/s (Answer)}$$

Sylhet Gas Fields Limited (SGFL)-2010

1. Draw the stress and strain diagram for mild steel showing the ultimate strength, breaking strength, yield strength on it.
2. A concentrated or point load p act on the simply supported beam.
3. A steel rod of 1 cm² in area and 1 cm in length pulled by 2000 kg where $E = 200$ GPa. Find the elongation.

Answer: Question-3, Gas Transmission Company Ltd. (GTCL 2010)

4. State the Bernoulli's equation for real fluid and ideal fluid.
5. Draw the characteristic curve of centrifugal pump.
6. A centrifugal pump having capacity 0.02 cusec can lift water at height at 100 ft. If the efficiency is 62%, find HP.
7. A refrigerating plant can produce 100 tons in 24 hrs. Its specific heat 4.2 kJ/kg maintained temperature 0°C. Find the cooling capacity of refrigeration.
8. How can you identify a petrol and diesel engine?

Answer: Question-10, Power Development Board (PDB)-2010.

9. Write the functions of economizer and safety valve of a steam boiler.

[All the questions are similar to Power Development Board (PDB)-2010.]

Jalalabad Gas T&D System-2010

1. Convert the absolute pressure of vacuum pressure 10 mm of mercury into N/m² taking 10.3 m of water as atmospheric pressure.

$$\text{Solution: } P = \frac{10}{760} \times 101325 = 1333.22 \text{ N/m}^2$$

2. If a furnace wall of 200 mm of heat capacity $310 \text{ w/m}^0\text{c}$ is insulated with 30 mm of brick having capacity $20 \text{ w/m}^0\text{c}$ temperature is 980^0c and outer most per square area of the furnace.

3. Draw the temperature profile for a parallel flow, counter flow heat exchanger.

4. A vapour compressor refrigerator having a cooling capacity of 8 tonnes. Find the power required.

Solution:

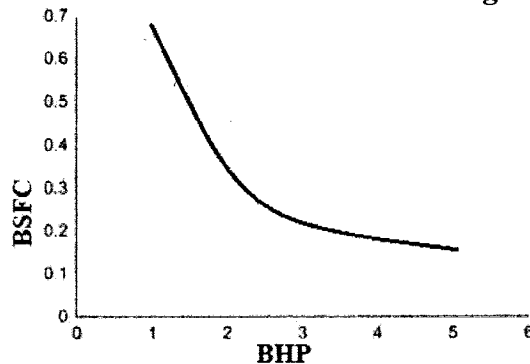
$$\text{COP} = \frac{\text{Refrigeration effect}}{\text{Power input}}$$

$$\text{or, Power input} = \frac{\text{Refrigeration effect}}{\text{COP}} = \frac{8 \times 3.5}{\text{COP}} \quad [\text{Data insufficient}]$$

5. What is the physical significance of Reynolds and Nusselts no.

6. A cylinder having diameter 200 mm and thickness 50 mm is subjected to normal pressure 150 KPa. What should be the external pressure?

7. Draw the BHP vs BSFC curve when the ICE under testing.



8. What is Euler's formula for column of hinged ends and when a column is subjected to 986 N bucking loads? Find EI.

Solution: Euler's formula, $P_{cr} = C \frac{\pi^2 EI}{L^2}$ For both end hinged, $C = 1 \therefore P_{cr} = \frac{\pi^2 EI}{L^2}$

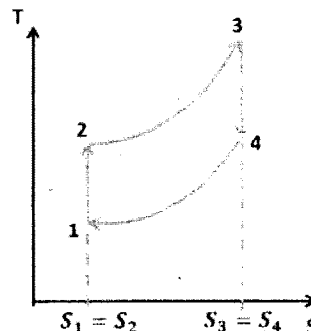
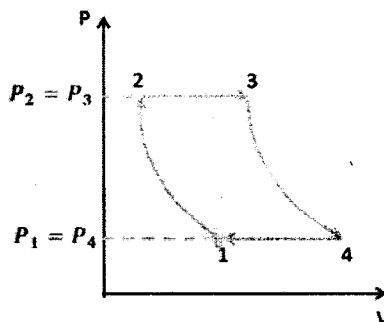
$$\therefore EI = \frac{P_{cr} L^2}{\pi^2} = 99.9 L^2$$

9. What are the types of gear and write at least 1 application of them.

Solution: Same as question-1 Power Grid Company of Bangladesh (PGCB)-2015

10. Draw top and front view of the following object.

11. Draw the P-V and T-S of air standard Joule Brayton cycle.



12. Abbreviation (a) SAPTA (b) GAT (c) VSAT

Answer: SAPTA- South Asian Preferential Trade Agreement

GAT- Guidance Automation Toolkit

VSAT- Very Small Aperture Terminal

Bangladesh Council of Scientific and Industrial Research (BCSIR-2011)

1. Draw front view and sectional view of the following object.
2. Differentiate between beam and column.
3. Show four types of beam using schematic diagram.
4. Name of four types of gear with one specific application of each types.
5. What is meant by boiler capacity of 3 ton/hr. and 100 °c comment on the actual capacity of a boiler?
6. What is steam turbine? Draw a block diagram of the power system where steam turbine is used.
7. Draw a block diagram of the power cycle where a gas turbine is used.
8. Distinguish between CIE & SIE.
9. What is bsfc? How is it related with engine load?
10. Briefly explain the fundamental laws related to heat conduction and convection.
11. What is cavitation? Name two problem associated with this.
12. Abbreviation CHP, CHF, ASHARE, ASTM.

Answer:

CHP: Combined heat and power

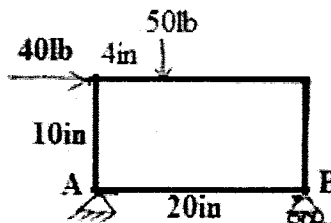
CHF: critical heat flux

ASHARE: American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASTM: American Society for Testing and Materials

13. Problem on heat loss.

[All the questions are discussed in other job question solutions]

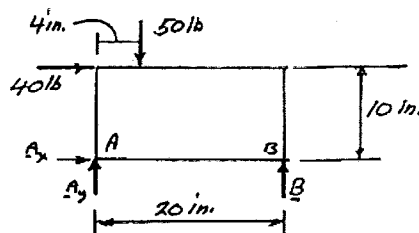
Bangladesh-China Power Company (Pvt.) Limited (BCPCL)**Post: Assistant Engineer (Mechanical)****Time-10.00AM to 11.30AM****Date:25.11.2016****Exam Hall: CE Building, BUET****1. Draw the schematic diagram of Rankine cycle with T-S diagram.****Answer:** Question-6, Power Grid Company Ltd.(PGCB)-2017**2. Draw the P-H and T-S diagram of standard vapor compression system mentioning the thermodynamic processes.****Answer:** Question-14, North West Power Generation Company Limited (NWPGL)-2015**3. Write the name of five largest power plants of Bangladesh.****4. Two helical springs of stiffness 15 N/mm and 10 N/mm are connected in series. Find the equivalent stiffness.****Answer:** Question-9, Titas Gas Transmission and Distribution Company Limited-2018**5. A vapor compression refrigeration system as to handle a cooling load of 2 ton. If the COP of the refrigeration system is 3.5, then find out the amount of heat rejection from the condenser.****Answer:** Question-6, Bangladesh Petroleum Exploration & Production Company Limited (BAPEX)-2016**6. Find out the reaction at B.****Solution:**

$$+\circlearrowleft \Sigma M_A = 0:$$

$$\Rightarrow B \times 20 - 50 \times 4 - 40 \times 10 = 0$$

$$\Rightarrow B = +30 \text{ lb}$$

$$\therefore B = 30.0 \text{ lb } \uparrow \quad (\text{Answer})$$

**7. Water flows through a pipe of 500mm in diameter 300m long with a velocity 2 m/s. Find the head loss due to friction, = 0.005. Use Darcy-Weisbach equation.****Solution:** Question-1, Rural Power Company Limited (RPCL)**8. A wall of a furnace is made up of inside layer of brick 120mm thick. The temperatures at the inside surface of silica-brick wall and outside of magnesite brick**

wall are 725°C and 110°C respectively. The contact thermal resistance between the two walls at the interface is $0.0035^{\circ}\text{Cm}^2\text{hr/Kcal}$. If the thermal conductivities of silica and magnesite bricks are $1.7 \text{ Kcal/m}^{\circ}\text{Chr}$ and $5.8 \text{ Kcal/m}^{\circ}\text{Chr}$. Calculate the rate of heat loss per unit area of walls.

Solution: Given, $L_A = 120\text{mm} = 0.12\text{m}$

$L_B = 240\text{mm} = 0.24\text{m}$

$k_A = 1.7\text{W/m}^{\circ}\text{C}$; $k_B = 5.8\text{W/m}^{\circ}\text{C}$

The contact thermal resistance,

$(R_{th})_{cont} = 0.0035^{\circ}\text{C/W}$

The temperature at the inside surface of silica brick wall,

$t_1 = 725^{\circ}\text{C}$

The temperature at the outside surface of the magnesite brick wall, $t_4 = 110^{\circ}\text{C}$

i) The rate of heat loss per unit area of wall, q :

$$q = \frac{\Delta t}{\sum R_{th}} = \frac{\Delta t}{R_{th-A} + (R_{th})_{cont} + R_{th-B}}$$

$$= \frac{(t_1 - t_4)}{L_A/k_A + 0.0035 + L_B/k_B}$$

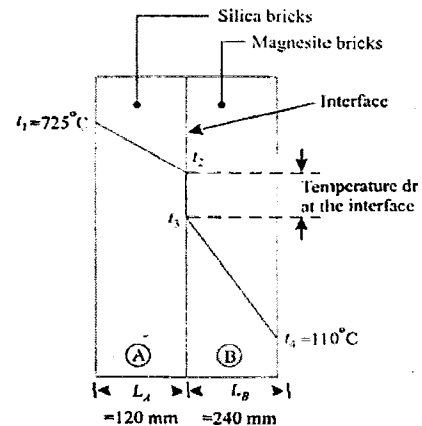
$$= \frac{(725 - 110)}{0.12/1.7 + 0.0035 + 0.24/5.8}$$

$$= \frac{615}{0.0706 + 0.0035 + 0.0414}$$

$$= 5324.67 \frac{\text{W}}{\text{m}^2}$$

\therefore The rate of heat loss per unit area of wall,

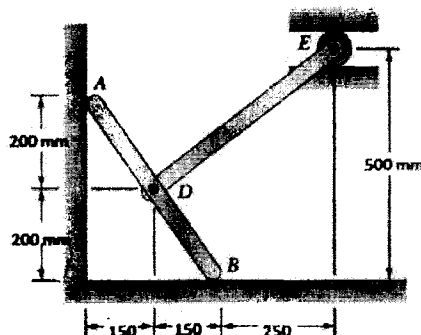
$q = 5324.67\text{W/m}^2$ (Answer)



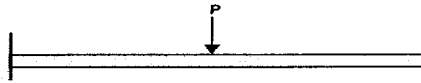
9. Draw the characteristics curve of centrifugal pump.

Answer: Question-5; Power Development Board (PDB)-2010

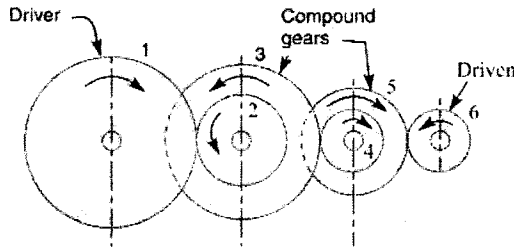
10. Two 500mm rods are pin-connected at D as shown. Knowing that B moves to the left with a constant velocity of 300mm/s, determine at the instant shown (a) the angular velocity of ED rod, (b) the velocity of A.



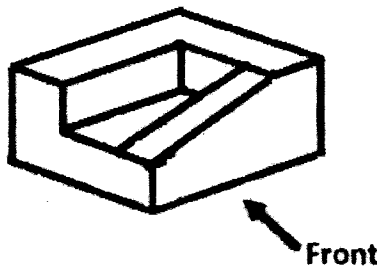
Solution: Question-22, Electricity Generation Company of Bangladesh (EGCB)-2017

11. Draw the SFD & BMD.

Solution: Question-9; Gas Transmission Company Limited (GTCL)

12. Gear math (similar)

Solution: Question-7, Power Grid Company of Bangladesh (PGCB)-2018

13. Draw FRONT, RHS and TOP view.

Answer: Question-15, Ashuganj Power Station Company Ltd. (APSCL)-2016

Bangladesh Ordnance Factory (BOF)

Post: Assistant Engineer (Mechanical)

Date: 04.08.2017

Exam Hall: Gazipur Cantonment College

1. Write down difference between Brake and clutch.
2. Write down difference between motor and generator.
3. Draw P-V and T-S diagram of Otto cycle.
4. Write down Bernoulli's equation for ideal fluid.
5. Draw p-h diagram for vapour compression refrigeration system.
6. What is boiler mountings and accessories?
7. Draw the characteristics stress-strain curve.
8. Math related to basic heat transfer. ($Q = -kA \frac{dT}{dx}$)
9. Math related to power of pump. ($P = \frac{\gamma QH}{\eta}$)

10. Elaborate these- SDG, SPARRSO, DGFI etc.

SDG- Sustainable Development Goals

SPARRSO- Space Research and Remote Sensing Organization

DGFI-Directorate General of Forces Intelligence

[উপরের সকল প্রশ্নের উত্তর আগের প্রশ্ন সমাধানগুলোতে আলোচনা করা হয়েছে।]

[সরল সুদ-কষার একটা পাটিগণিত অঙ্কসহ একটা বীজগণিত অঙ্ক এবং আরো কিছু প্রশ্ন ছিল।]

Nuclear Power Plant Company Bangladesh(NPCBL)

Post: Executive Trainee (Mechanical)

Time 10.00AM to 11.30AM

Date:04.08.2017

Exam Hall: BUET

Non-Departmental MCQ- $40 \times 0.5 = 20$; Departmental MCQ- $40 \times 0.5 = 20$; Departmental Theory- $10 \times 6 = 60$

1. Draw a block diagram of a steam turbine power plant only with the four elements. Draw the corresponding T-S diagram.

Answer:

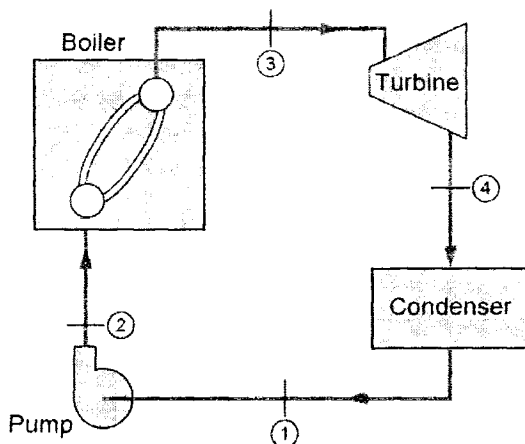


Figure: Simple steam power plant that operates on the Rankine cycle

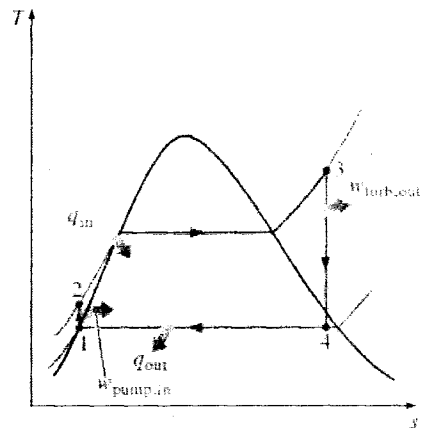


Fig.: T-S diagram of Rankine cycle

2. A hydroelectric pump is used to lift water which has a suction head of 1.6m and delivery head of 17.4m. Discharge of this pump is $60\text{m}^3/\text{h}$. Determine the power of the motor if the combined efficiency of the drive motor and the pump is 70%.

Solution:

Given, $h_s = 1.6\text{m}$; $h_d = 17.4\text{m}$ $\therefore H_m = h_s + h_d = 19\text{m}$, $Q = 60\text{m}^3/\text{h}$; $\eta = 70\% = 0.7$

We get,

$$P = \frac{\rho g H_m Q}{\eta} = \frac{1000 \times 9.81 \times 19 \times 60}{0.7 \times 3600} = 4.5\text{KW (Ans.)}$$

3. Water flows through a pitot tube of diameter 10cm has the end pressure is 2kPa. Determine velocity of flow and flow rate.

Solution:

Given, $D=0.1\text{m}$; $P=\rho gh=2000\text{Pa}$; $\therefore gh=2$; Let, $C_v = 1$;

We get, $V = C_v \sqrt{2gh} = 1 \times \sqrt{2 \times 2} = 2\text{ms}^{-1}$ (Ans.)

$$Q = AV = \frac{\pi}{4} \times D^2 \times 2 = \frac{\pi}{4} \times 0.1^2 \times 2 = 0.016\text{m}^3/\text{s} \text{ (Answer)}$$

4. A furnace wall is made up of refractory bricks of 100mm thick and area 2m^2 . The inner and outer surfaces of the wall have temperature of 1000°C and 200°C . Heat transfer coefficient is 20W/mk . Find the heat flow rate.

Solution: Given, $\Delta x=0.1\text{m}$; $\Delta T=800^\circ\text{C}=800\text{K}$; $k = 20\text{W/mk}$

We get,

$$Q = -KA \frac{\Delta T}{\Delta x} = \frac{20 \times 2 \times 800}{0.1} = 320\text{KW} \text{ (Answer)}$$

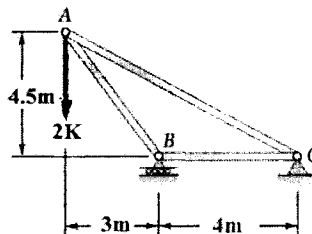
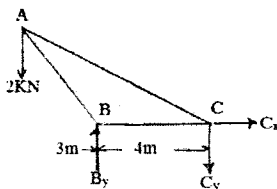
5. Which type of reaction is occurred in a Nuclear Power Plant? What is the function of control rod?

Answer: The reaction that takes place in nuclear power plants is nuclear fission, which is a chain reaction.

Function of control rod:

Control rods are used in nuclear reactors to control the fission rate of uranium and plutonium. They are composed of chemical elements such as boron, silver, indium and cadmium that are capable of absorbing many neutrons without themselves fissioning.

6. Determine reaction force of point B along vertical direction of the truss shown.

**Solution:**Free Body Diagram of Truss

Taking moment at C, We get,

$$B_y \times 4 - 2 \times 7 = 0$$

$$\text{or, } B_y = 3.5\text{KN} \text{ (Ans.)}$$

7. A cylindrical shaft is under a torsional force of 100N-m . inside and outside dia of the shaft is 30mm and 50mm . Determine maximum shear stress of the shaft.

Solution:

Given, $T=100\text{N-m}$, $D_o = 50\text{mm} = 0.05\text{m}$; $D_i = 30\text{mm} = 0.03\text{m}$; $\tau_{\max} = ?$

We get,

$$\tau_{\max} = \frac{16TD_0}{\pi(D_0^4 - D_i^4)} = \frac{16 \times 100 \times 0.05}{\pi(0.05^4 - 0.03^4)} = 4.7 \text{ MPa (Answer)}$$

8. A flat belt is with two pulleys of equal diameter. Maximum allowable tension in the tight side is 800N. The coefficient of friction of the pulley is 0.03. Determine the maximum force in the slack side.

Solution: Given, $T_1 = 800\text{N}$, $\mu = 0.03$, $\theta = \pi$ radian; $T_2 = ?$

$$\text{We get, } \frac{T_1}{T_2} = e^{\mu\theta}$$

$$\text{or, } T_2 = \frac{800}{e^{0.03 \times \pi}} = 728.05\text{N (Ans.)}$$

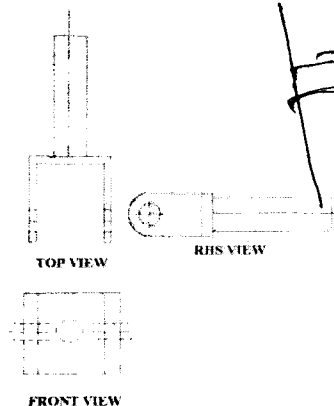
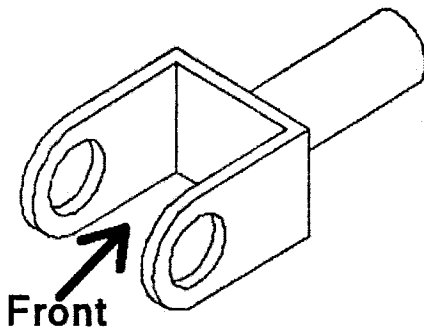
9. For a cantilever beam deflection, $\delta = Wl^3/3EI$ and $W=200\text{ N}$, $L= 10\text{cm}$, $E= 200\text{GPa}$, $I=400\text{mm}^4$. Determine natural frequency of the transverse vibration.

Solution:

$$\text{We get, } \delta = \frac{Wl^3}{3EI} = \frac{200 \times 10^3}{3 \times 200 \times 10^9 \times 400 \times 10^{-12}} = 8.33 \times 10^{-4} \text{ m}$$

$$\therefore f = \frac{1}{2\pi} \sqrt{\frac{g}{\delta}} = \frac{1}{2\pi} \sqrt{\frac{9.81}{8.33 \times 10^{-4}}} = 17.3 \text{ Hz (Ans.)}$$

10. Draw TOP VIEW, RHS VIEW and FRONT VIEW.



$$f = \frac{1}{2\pi} \sqrt{\frac{g}{\delta}}$$

Departmental MCQ

1. The fluid state after throttling – **liquid and vapor**
2. Chiller is used in central air conditioning unit- cools the water
3. Maximum normal stress theory and Maximum shear stress theory- For brittle and ductile respectively.
4. Continuity equation deals with the law of conservation of
 - a. mass
 - b. energy

- c. momentum
 - d. none of the above
5. The Kaplan turbine is a
- a. Impulse – reaction turbine
 - b. Impulse turbine
 - c. **Reaction turbine**
 - d. None of the above
6. For safety, control and operation which one is used?
- a) **Boiler mountings**
 - b) Boiler accessories
 - c) Boiler mountings and accessories
 - d) All of the above
7. Stoichiometric air fuel ratio means ratio of-
- a) Mass of air to mass of fuel
 - b) Mass of fuel to mass of air
 - c) **Volume of air to volume of fuel**
 - d) Volume of fuel to volume of air
8. Octane number increases means the-
- a) Increasing of knocking tendency
 - b) Increasing the possibility of auto ignition
 - c) **Increasing the resistance to knocking**
 - d) –
9. Air conditioning means
- a. cooling and dehumidifying
 - b. heating and humidifying
 - c. supplying quality air
 - d. **all of the above**
10. Which is correct for Maximum torsional shearing stress –
- a) TJ/r b) Tr/J c) Tr/I d) $\frac{16PR}{\pi D^3} \left(1 + \frac{d}{4R}\right)$

বাকিগুলো মনে নেই।

Non-departmental MCQ

1. What is the abbreviation of 'SRAM'?

Answer Static Random Access Memory.

2. RAID used for---

Answer increasing the performance and/or reliability of data storage.

3. Gobi desert is between--?

$$= \frac{PL}{AE}$$

Answer China and Mongolia.

4. Constantan alloy made of-

Answer Ni, Zn.

৫. ও কি ধরনের বর্ণ

Answer ব্যঞ্জন ও বর্ণীয়.

6. Mujibnagar sector no--?

Answer 8

7. What is the meaning of "call it a day"?

Answer It means to stop work or other activities which was engaged in.

8. Correct the spelling 'Paralal'.

Answer Parallel.

9. Correct the sentence 'where were u born'?

Answer Right answer.

10. He retired - the company and move-

Answer from, on.

11. Correct the sentence 'what you most like about me'?

Answer what do u like most about me?

12. He can play---flute.

Answer a.

13. What was the Bangla calendar date?

Answer 20 shrabon, 1424.

14. Ominous antonym is---?

Answer Auspicious.

15. Fuel supplier name of Rooppur Nuclear plant is---??

Answer Rosatom

19. What is 'Nuclear reactor' meaning in bangla?

Answer পারমাণবিক চুল্লি

20. What is 'Atomic energy' meaning in bangla?

Answer পারমাণবিকশক্তি

Sundarban Gas Company Limited (SGCL)

Time 10.00AM to 11.30AM

Date:07.07.2017

Exam Hall: BUET

1. Draw the actual and air standard Otto cycle P-V diagram with all thermodynamic processes.

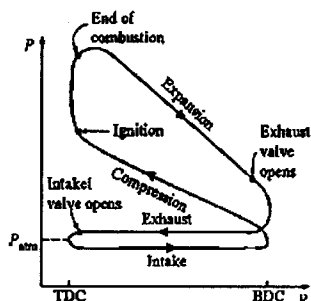


Fig.: Actual Otto cycle

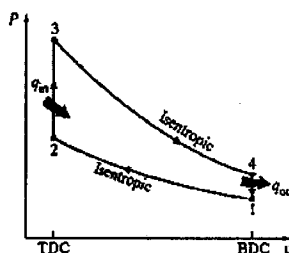


Fig.: Air Standard Otto cycle

Process 1-2: Reversible adiabatic compression of air

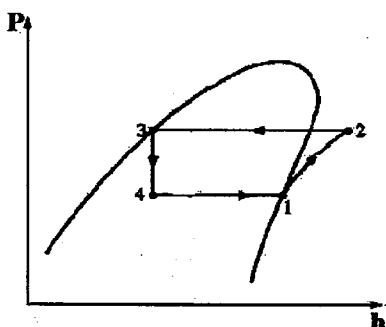
Process 2-3: Heat addition at constant volume

Process 3-4: Reversible adiabatic expansion of air

Process 4-1: Heat rejection at constant volume

2. Draw P-h diagram of vapor refrigeration compression cycle with showing thermodynamic processes.

Answer:



Process 1-2: Isentropic compression of saturated vapour in compressor

Process 2-3: Isobaric heat rejection in condenser

Process 3-4: Isenthalpic expansion of saturated liquid in expansion device

Process 4-1: Isobaric heat extraction in the evaporator

3. A four cylinder 4 stroke engine has 10 cm bore and 10 cm stroke. Clearance volume is 50π cc (157 cc) i. Determine compression ratio, ii. What is the CC of this engine?

Solution: Given, $N=4$; $D=10\text{cm}$; $L=10\text{cm}$; $V_c = 50\pi \text{ cc} = 157 \text{ CC}$;

$$\therefore V_s = \frac{\pi}{4} D^2 L = \frac{\pi}{4} \times 10^2 \times 10 = 785.4 \text{ cc}$$

$$\text{i) Compression ratio} = \frac{V_s + V_c}{V_c} = \frac{785.4 + 157}{157} \approx 6 \text{ (Answer)}$$

$$\text{ii) Engine CC} = 4 \times V_s = 4 \times 785.4 = 3141.6 \approx 3142 \text{ CC (Answer)}$$

4. A 250 KW engine has a thermal efficiency of 42.2%. If the calorific value of the fuel is 40.3 MJ/Kg, determine a) Input power of the engine b) specific fuel consumption of the engine in Kg/KWh.

Solution: Given, Power Output= 250KW; $\eta=42.2\%$; $C=40.3\text{MJ/Kg}$;

a) Input power of the engine

$$\text{We get, } \eta = \frac{\text{Power Output}}{\text{Power Input}}$$

$$\therefore \text{Power Input} = \frac{250}{0.422} = 592.42 \text{ KW (Answer)}$$

b) Power Input = $\dot{m}_f C = 592.42 \text{ KW}$

$$\therefore \dot{m}_f = \frac{\text{Power Input}}{C} = \frac{592.42}{40.3 \times 10^3} = 0.0147 \text{ Kg/ sec}$$

$$\therefore \text{sfc} = \frac{\dot{m}_f}{\text{Power Output}} = \frac{0.0147 \times 3600}{250} = 0.212 \text{ Kg/KWh (Answer)}$$

5. Gas flows at $0.03 \text{ m}^3/\text{min}$ at 23°C and 100 KPag. Determine the volume flow rate at atmospheric condition.

Solution: Given, $P_1 = 100\text{KPag} = 201\text{KPa(absolute)}$; $V_1 = 0.03\text{m}^3/\text{min}$;

$T_1 = 23 + 273 = 296\text{K}$; $P_2 = 101\text{KPa(absolute)}$; $T_2 = 25 + 273 = 298\text{K}$; $V_2 = ?$

$$\text{We get, } \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\text{or, } \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

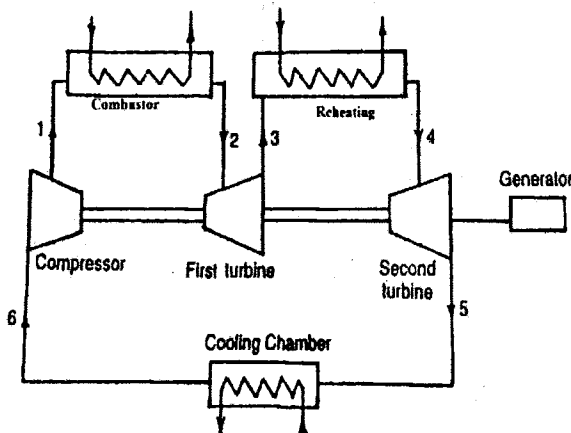
$$\text{or, } \frac{201 \times 0.03}{296} = \frac{101 \times V_2}{298}$$

$$\text{or, } \frac{100 \times 0.03}{296} = \frac{101 \times V_2}{298}$$

$$\text{or, } V_2 = 0.06 \text{ m}^3/\text{min (Answer)}$$

6. Draw a closed loop gas turbine Cycle schematic diagram with reheating and specify the thermodynamic processes clearly.

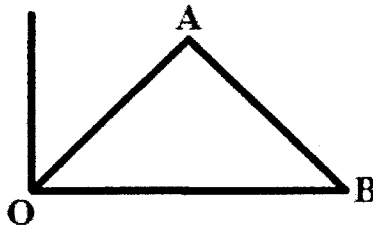
Solution:



Schematic arrangement of a closed cycle gas turbine with reheating

- (6-1) Isentropic compression,
- (1-2) Constant pressure Combustion
- (3-4) Constant pressure Reheating
- (4-5) Isentropic expansion
- (5-6) Constant pressure heat rejection

7. OAB is an equilateral triangle having an arm of 1 m in each side. The elevations of the points O, A & B are 0, 100 & 500 cm. What is the area of the horizontal projection of the triangle?



Solution:

$$OB' = \sqrt{1^2 - 0.5^2} = 0.866\text{m}$$

$$OA' = \sqrt{1^2 - 0.1^2} = 0.995\text{m}$$

$$A'B' = \sqrt{1^2 - (0.5 - 0.1)^2} = 0.917\text{m}$$

$$S = \frac{0.866 + 0.995 + 0.917}{2} = 1.389\text{m}$$

$$\Delta O'A'B' = \sqrt{S(S - OB')(S - OA')(S - A'B')}$$

$$= \sqrt{1.389(1.389 - 0.866)(1.389 - 0.995)(1.389 - 0.917)}$$

$$= 0.368 \text{ m}^2 \text{ (Answer)}$$

8. A motor can lift 500 kg water to 15 m height in 9.1 seconds. a) Determine the work done by the motor, b) power of the motor.

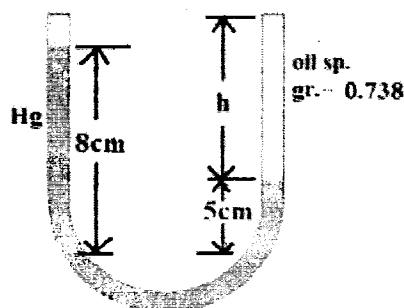
Solution:

Given, $m=500\text{Kg}$; $h=15\text{m}$, $t= 9.1\text{sec}$,

a) We get, Workdone, $W = mgh = 500 \times 9.81 \times 15 = 73575\text{J} = 73.575\text{KJ}$ (Ans.)

b) Power of the motor $= \frac{mgh}{t} = \frac{73.57}{9.1} = 8.08 \text{ KW}$ (Ans.)

9. Determine h of a fluid column having $SG = 0.738$ neglecting the atmospheric pressure.



Solution:

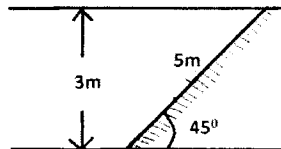
$$(h\rho g)_{\text{Hg}} = (h\rho g)_{\text{Hg}} + (h\rho g)_{\text{oil}}$$

$$\text{or, } 8 \times 13.6 \times 9.81 = (5 \times 13.6 \times 9.81) + (h \times 0.738 \times 9.81)$$

$$\text{or, } 1067.328 = 667.08 + 7.24h$$

$$\text{or, } h = 55.28 \text{ cm}$$

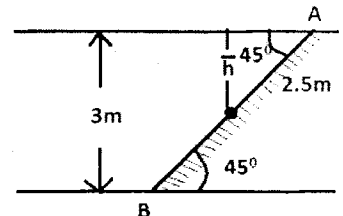
$$\therefore h = 55.28 \text{ cm (Answer)}$$

10. Determine the pressure of water on the inclined plate having width 3m. (Similar)**Solution:**

$$\text{Here, Area of the gate} = 3 \times 5 = 15 \text{ m}^2$$

$$\bar{h} = 2.5 \sin 45^\circ = 1.77 \text{ m}$$

$$\therefore \text{Resultant Force, } F = \rho g \bar{h} A = 1000 \times 9.8 \times 1.77 \times 15 = 260.19 \text{ kN (Ans.)}$$

**11. Which load a 4 cm dia bolt can resist if maximum strength is 250 MPa and factor of safety is 4?****Solution:**

$$\text{Working Strength, } \sigma_w = \frac{250}{4} = 62.5 \text{ MPa}$$

$$P = \sigma_w \times A = 62.5 \times \frac{\pi}{4} \times (0.04)^2 = 0.0785 \text{ MN} = 78.54 \text{ kN (Answer)}$$

12. Water is flowing at a velocity of 2 m/s through a pipe where two pressure gauges are attached at point 1 and 2. Reading of the gauge 1 is 100 KPa. What is the reading of the gauge at point 2?**Solution:**

$$P_2 = P_1 + \frac{1}{2} \rho V^2$$

$$= 100 + \frac{1}{2} \times \frac{1000}{1000} \times 2^2 = 102 \text{ KPa. (Answer)}$$

12. Draw the front, top and LHS view. (Same as BCPCL-2016)

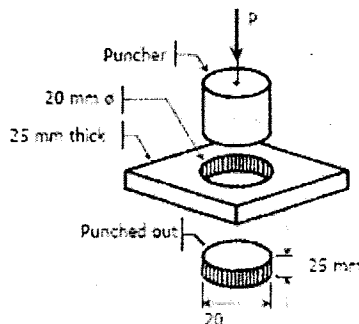
BUET MSc-2017

Date: 2.10.2017

Exam Hall: BUET

These Questions are just similar; don't judge these as exact questions

1. What force is required to punch a 20-mm-diameter hole in a plate that is 25 mm thick? The shear strength is 350 MN/m^2 .



5 $\pi r^2 t$

$\int 350 \pi r^2 dr$

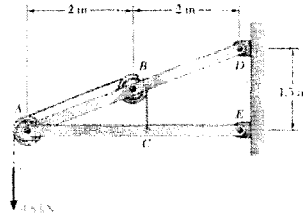
$0 \rightarrow 20$

$350 \cos 45^\circ \times 2$

$\left(\frac{5}{2}\right) \cos$

2. A cantilever of length 2 meter fails when a load of 2KN is applied at the free end. If the section of the beam is $40\text{mm} \times 60\text{mm}$, find the stress at the failure. (Similar)

3. Knowing that each pulley has a radius of 250 mm, determine the components of the reactions at D and E. (Almost similar)



4. Draw a velocity profile for fluid flow through a spherical body.
5. Draw a velocity profile for fluid flow through a flat plate.
6. Find the natural frequency of a spring where k and mass of load is given. Neglect the mass of spring.
7. Draw a T-S diagram for gas turbine cycle with re-heater and intercooling.
8. Air craft velocity related math. (Stagnation Formula may be)
9. Reynolds number related math. Find the pipe dia. (Reynolds number was not given, it was said to use conventional value for certain conditioned pipe flow.)
10. Isothermal and Isobaric workdone calculation related math.
11. Total heat required for melting of certain temperature ice into water. (HSC level)
12. Check the cycle is irreversible or not by finding out the efficiency.
13. Power plant related math: find average load and total power generated.
14. Pump math. (Find Q and H)
15. Gear related math.
16. Stress and deflection was given find the minimum area.
17. Modified Bernoulli's equation with losses.

18. A DC input was given and some data are provided. Find out the binary value.

19. Short MCQ type 3 questions.

20. Drawing.

Power Grid Company Ltd.(PGCB)

Time 10.00AM to 11.30AM

Date:03.03.2017

Exam Hall: MIST

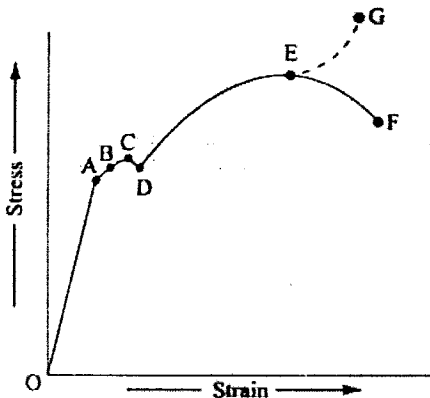
Analytical Ability: 20; GK: 20; English 20 Technical- 40

1. State Zeroth law of thermodynamics.

Answer: Zeroth Law of Thermodynamics: When two systems are each in thermal equilibrium with a third system, then the two systems are also in thermal equilibrium with one another.

2. Draw stress-strain curve for mild steel.

Answer:



A- Proportional limit

B- Elastic limit

C- Upper yield point

D- lower yield point

E- Ultimate stress/strength

F- Breaking stress/strength

G- Actual Rupture Strength

3. Write the difference between fin efficiency and effectiveness.

Answer: Fin Efficiency,

$$\eta_{\text{fin}} = \frac{\text{Actual heat transfer by the fin } (Q_{\text{fin}})}{\text{Maximum heat that would be transferred if whole surface of the fin is maintained at the base temperature } (Q_{\text{max}})}$$

$$\text{Effectiveness of fin, } \varepsilon_{\text{fin}} = \frac{\text{Heat transfer rate with the fin } (Q_{\text{with fin}})}{\text{Heat transfer rate without the fin } (Q_{\text{without fin}})}$$

4. Write the difference between case hardening and flame hardening.

Case Hardening	Flame Hardening
1. Case hardening is a technique in which a metal surface is reinforced by the adding of	1. Flame hardening is a surface-hardening method that involves heating a metal with a

a thin layer of another metal alloy that is more durable, increasing the object's life.	high-temperature flame, followed by quenching.
2. Case hardening is suitable both for carbon and alloy steels, and typically mild steels are used.	2. It is used on medium carbon, mild or alloy steels or cast iron to produce a hard, wear-resistant surface.
3. This is particularly significant for the manufacture of: Machine parts, Carbon steel forgings, Carbon steel pinions etc.	3. Typical flame-hardening applications include: Blades, Gears, Rolls, Cams, Automotive components etc.
4. Case hardened steel is formed by diffusing carbon (carburization), nitrogen (nitriding) and/or boron (boriding) into the outer layer of the steel at high temperature, and then heat treating the surface layer to the desired hardness.	4. Flame hardening uses direct impingement of an oxy-gas flame onto a defined surface area.

5. What is the function of economizer and baffles.

Answer: Function of Economizer: Economizer is a device used for heating feed water which is supplied to the boiler by utilizing heat in the exhaust flue gases before leaving through the chimney.

Function of Baffles: Baffles are used in Boilers to reduce turbulence in the flow of the hot combustion gases over the boiler tubes. The baffles maintain proper velocity of the gases which enables efficient energy transfer.

Baffles also guide the fly ash and slag to the proper place for deposition from where they can be easily removed.

If the Baffles are damaged, it will result in overheating at certain places and poor heating in others.

6. Draw the schematic diagram of Rankine cycle with T-S diagram.

Answer:

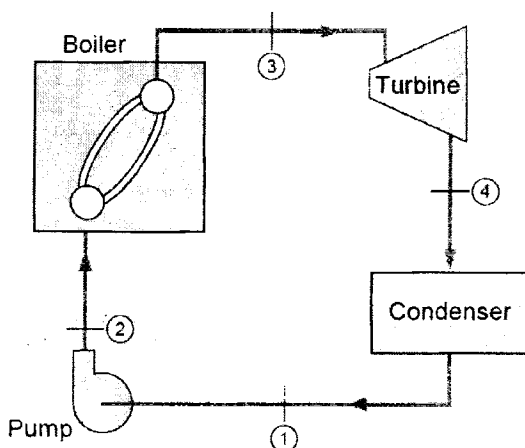


Figure: Simple steam power plant that operates on the Rankine cycle

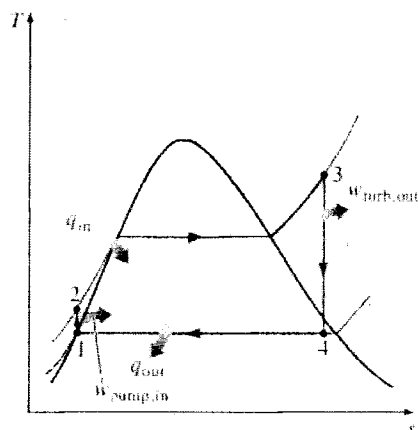


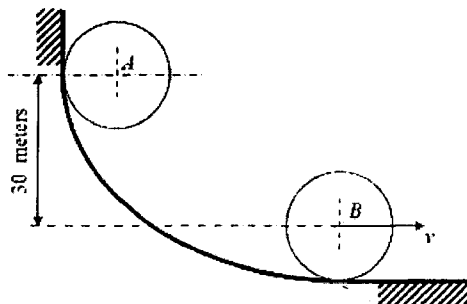
Fig.: T-S diagram of Rankine cycle

7. Write notes on- Knocking and ignition lag.

Answer: Detonation/ knocking: The rapid auto-ignition of a portion of a fuel causes a pressure wave of high intensity to be set up in the cylinder of an I.C. engine. This pressure wave of high intensity propagates rapidly through the gas gives a violent blow to the walls of the cylinder, to the combustion chamber and to the piston. A loud pulsating noise known as knocking is produced which gives violent vibration to the engine. The term detonation is used to indicate precession of gas vibration and term knock is used to include all phenomenon that arise from auto-ignition. The knock in S.I. engines is characterized by sudden auto-ignition of the charge farthest away from the spark plug while in case of C.I. engines it is characterized by the sudden auto-ignition of the mixture at the very beginning of the combustion process.

Ignition lag is defined as the time taken by the fuel after injection to reach up to auto-ignition temperature.

8. A circular disc of radius 100mm and mass 1 Kg, initially at rest at position A, rolls without slipping down a curved path as shown in figure. What is the speed v of the disc when it reaches position B? Consider gravitational acceleration as 10m/s^2 .



Solution: Here, $H=30\text{m}$, $v=?$

$$\text{We get, } mgH = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2$$

$$\text{Here, } I = \frac{mr^2}{2}; \omega = \frac{v}{r}$$

Then,

$$mgH = \frac{1}{2} \frac{mr^2}{2} \left(\frac{v}{r}\right)^2 + \frac{1}{2}mv^2$$

$$\text{or, } 10 \times 30 = \frac{v^2}{4} + \frac{v^2}{2}$$

$$\text{or, } v^2 = 400$$

$$\therefore v = 20\text{m/s (Answer)}$$

9. A centrifugal pump delivers $0.055\text{m}^3/\text{s}$ of water to a total height of 16m. The diameter of the pipe 150 mm and it is 22mm long. If the overall efficiency is 75%, calculate power needed to drive the pump. Take friction coefficient factor, $f=0.05$ for the pipe. (Similar)

Solution: We get,

$$Q = \frac{\pi}{4} d^2 \times V$$

$$\text{or, } 0.055 = \frac{\pi}{4} (0.15)^2 \times V$$

$$\text{or, } V = 3.11 \text{ m/s}$$

$$\text{Again, } H_f = \frac{f v^2}{2gD} = \frac{0.05 \times 22 \times (3.11)^2}{2 \times 9.81 \times 0.15} = 3.62$$

$$\therefore \text{Total Head, } H = 16 + 3.62 + \frac{3.11^2}{2 \times 9.81} = 20.11$$

$$\text{We know, } \eta = \frac{Q \gamma H}{P}$$

$$\Rightarrow 0.75 = \frac{0.055 \times 9.81 \times 20.11}{P}$$

$$\Rightarrow P = 14.46 \text{ KW (Answer)}$$

10. Find out the efficiency for Otto cycle for the specific heat ratio (C_p/C_v) of the working fluid is considered as 1.50 and compression ratio is 10. If the cut-off ratio is 1.96 then what will be diesel cycle efficiency?

Solution: Given, $\gamma = 1.5$, $\rho = 1.96$, $r = 10$, $\eta_{\text{Otto}} = ?$ and $\eta_{\text{diesel}} = ?$

For Otto Cycle:

$$\eta_{\text{Otto}} = 1 - \frac{1}{(r)^{\gamma-1}}$$

$$\text{or, } \eta_{\text{Otto}} = 1 - \frac{1}{(10)^{1.5-1}}$$

$$\text{or, } \eta_{\text{Otto}} = 0.6837$$

$$\therefore \eta_{\text{Otto}} = 68.37\% \text{ (Answer)}$$

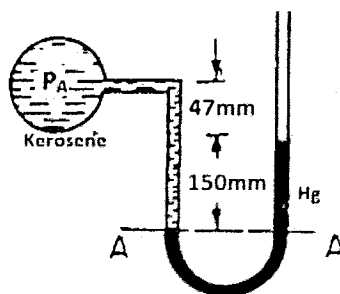
For Diesel Cycle:

$$\eta_{\text{diesel}} = 1 - \frac{1}{r^{\gamma-1}} \left[\frac{\rho^{\gamma}-1}{\gamma(\rho-1)} \right] = 1 -$$

$$\frac{1}{10^{0.5}} \left[\frac{(1.96)^{1.5}-1}{1.5(0.96)} \right]$$

$$= 0.6170 = 61.70\% \text{ (Answer)}$$

11. Calculate pressure P_A . Take Sp. gr. of kerosene is 0.823.



Solution:

Taking A-A as datum line.

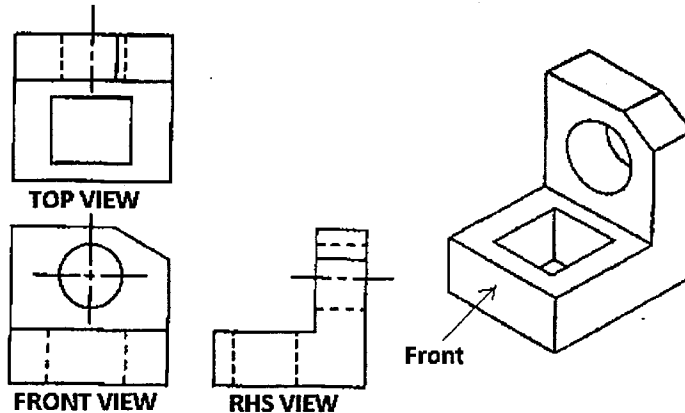
Pressure above A-A in the left limb

$$= 1000 \times 0.823 \times 9.81 \times (0.047 + 0.15) + P_A = 1590.51 + P_A$$

$$\text{Pressure above A-A in the right limb} = 1000 \times 13.6 \times 9.81 \times 0.150 = 20012.4$$

$$\text{Equating the two pressures, we get, } 1590.51 + P_A = 20012.4$$

$$\therefore P_A = 20012.4 - 1590.51 = 18421.89 \text{ Pa} = 18.43 \text{ KPa (Answer)}$$

12. Draw FRONT VIEW, TOP VIEW and RHS VIEW.

1. What is the capacity of Rampal power plant?

Answer: 1320MW

2. Who will collect the nuclear waste of Rooppur power plant?

Answer: Russia

3. When BPDB was formed?

Answer: 1972

4. Write the name of two subsidiaries of BPDB.

Answer: Ashuganj Power Station Company Ltd. (APSCL)

- Electricity Generation Company of Bangladesh (EGCB)

5. Elaborate:

HVDC- High-voltage direct current

NLDC- National Load Despatch Centre

6. How much power import from India through Bheramara?

Answer: 500MW

7. Power Generation target in 2021 is-

Answer: 24000 MW

8. What is the full form of ECNEC?

Answer: Executive Committee of the National Economic Council

9. What is the full form of BIMSTEC?

Answer: Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation

10. Who is the British person of the year in 2017?

11. Who is the chief of Samsung Company?

12. What is the length of Padma Bridge?

Answer: 6.15Km

13. How many goals of SDG?

Answer: 17

14. BREXIT date

Answer:

15. Sacked attorney general name is-

Answer:

16. Dutch Australian commando in BD liberation war was-

Answer: Ouderland, William AS

17. Name of the SAARC secretary general is-

Answer: Amjad Hussain B Sial

18. What is the full form of TPP?

Answer: Trans-Pacific Partnership

19. Who is the BSF chief?

Answer: K K Sharma

21. New Submarines of Bangladesh-

Answer: Nabajatra and Joyjatra

22. Name of the 100th test winning stadium for Bangladesh-

Answer: Sara Oval

23. International Peace keeper day-

Answer: 29 May

24. "Knowledge is power" is a statement by-

Answer: Francis Bacon

25. Sea area won by Bangladesh –

Answer: 19,467square kilometres

26. Translation from Bengali to English

(i) যেখানে শক্তি পরাজিত, সেখানে ভালোবাসা জয়ী

=Where the power loss, wins the love.

27. সন্ধি (২)

28. Sentence correction

29. 'একাত্তরের যীশু' –এর লেখক কে-

উত্তর: শাহরিয়ার কবির

30. বাংলা বর্ণমালায় মাত্রাহীন ব্যঞ্জনবর্ণ কয়টি?

উত্তর: ৬টি

বাকিগুলো মনে নেই। বেশ কিছু Analytical Questions ছিল।

Gross heat rate
heat rate = energy input / power generated

Coal Power Generation Company Bangladesh Limited (CPGCBL)

Post: Assistant Engineer (Mechanical)

Time 10.00AM to 11.30AM

Date: 23.03.2018

Exam Hall: BUET

1. A two unit coal fired power plant turbine-generator gross generation is 600MW (Gross) burns 4500tons of coal per day. The coal has a higher heating value (HHV) of 30 MJ/Kg. If 15% of gross power is consumed by the power station then, Determine (i) Gross heat rate (HR) and (ii) Net heat rate (HR).

$$\text{Energy input} = \frac{4500 \times 1000 \times 30 \times 10^6}{24} = 5625000 \times 10^6 \text{ J/hr} = 5625 \times 10^6 \text{ KJ/hr}$$

(i) **Gross heat rate (HR)**

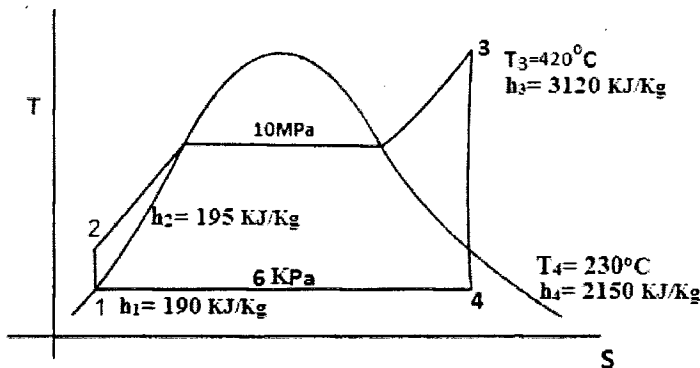
$$= \frac{\text{Energy Input}}{\text{Power Generation (Gross)}} = \frac{5625 \times 10^6}{600 \times 10^3} = 9375 \text{ KJ/KWhr (Answer)}$$

(ii) **Net generation power** = $600 - 600 \times 0.15 = 510 \text{ MW}$

Net heat rate (HR)

$$= \frac{\text{Energy Input}}{\text{Power Generation (Net)}} = \frac{5625 \times 10^6}{510 \times 10^3} = 11019.6 \text{ KJ/KWhr (Ans.)}$$

2. T-S diagram of a Rankine cycle corresponding to the pressure and temperature is shown below. Determine the (i) thermal efficiency and (ii) Back Work Ratio.



Solution: We get,

$$\begin{aligned} \text{Thermal Efficiency, } \eta &= \frac{W_T - W_P}{Q_{in}} \\ &= \frac{(h_3 - h_4) - (h_2 - h_1)}{h_3 - h_2} = \frac{(3120 - 2150) - (195 - 190)}{3120 - 195} \\ &= \frac{970 - 5}{2930} = 0.3293 = 32.93\% \text{ (Answer)} \end{aligned}$$

$$\begin{aligned} \text{Back Work Ratio, BWR} &= \frac{W_P}{W_T} \\ &= \frac{195 - 190}{3120 - 2150} = 0.005 \text{ (Answer)} \end{aligned}$$

3. A thermoelectric refrigerator melts 500ml water ($C_p = 4.18 \text{ KJ/Kg}^\circ\text{C}$) at 30°C to 5°C in 1 hour. The refrigerator consumes electrical power 70W. Determine the COP.

Solution:

$$\begin{aligned} \text{Here, } m &= \rho \times V = 1000 \text{ Kg/m}^3 \times 500 \text{ ml} = 1000 \text{ Kg/m}^3 \times 500 \times 10^{-6} \text{ m}^3 = 500 \times 10^{-3} \text{ Kg;} \\ C_p &= 4.18 \text{ KJ/Kg}^\circ\text{C}; \Delta T = 25^\circ\text{C}; t = 1 \text{ hr} = 3600 \text{ s}; W_R = 70 \text{ W} \end{aligned}$$

$$\text{Then, } Q_c = \frac{500 \times 10^{-3} \times 4.18 \times 1000 \times 25}{3600} = 14.51 \text{ W}$$

$$\therefore \text{COP} = \frac{Q_c}{W_R} = \frac{14.51}{70} = 0.21 \text{ (Answer)}$$

4. The percentage composition of a sample of coal is found to be as follows.

C	H ₂	O ₂	N ₂	S	Ash
88%	43%	4%	0.7%	1%	2%

Calculate the minimum air required for complete combustion of 5Kg of coal. Consider the amount of oxygen percentage at air is 22%.

Solution:

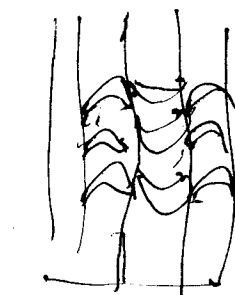
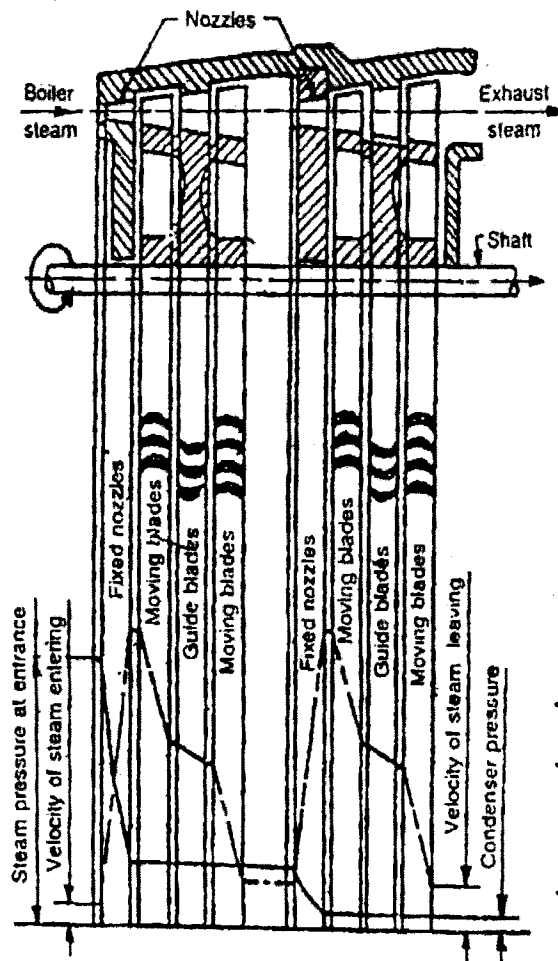
Minimum air required for complete combustion of 5Kg of Coal

$$= 5 \times \frac{100}{22} \left[\left(\frac{8}{3} C + 8H_2 + S \right) - O_2 \right] \text{ Kg}$$

$$= 5 \times \frac{100}{22} \left[\left(\frac{8}{3} \times 0.88 + 8 \times 0.043 + 0.01 \right) - 0.04 \right] \text{ Kg}$$

$$= 60.469 \text{ Kg (Ans.)}$$

5. Draw a schematic diagram of velocity compounding of an impulse turbine. Also show pressure and velocity distribution of the turbine.



6. Draw a block diagram of a coupled GT-ST power plant. Mention the name of the all components. [similar to previous year question]
7. A centrifugal pump delivers 30l/s of water at a height of 26m. A 3-phase, AC current supply to the motor voltage and current are 400V and 17A respectively. Determine the efficiency of the pump considering the power factor value is 1.

Solution:

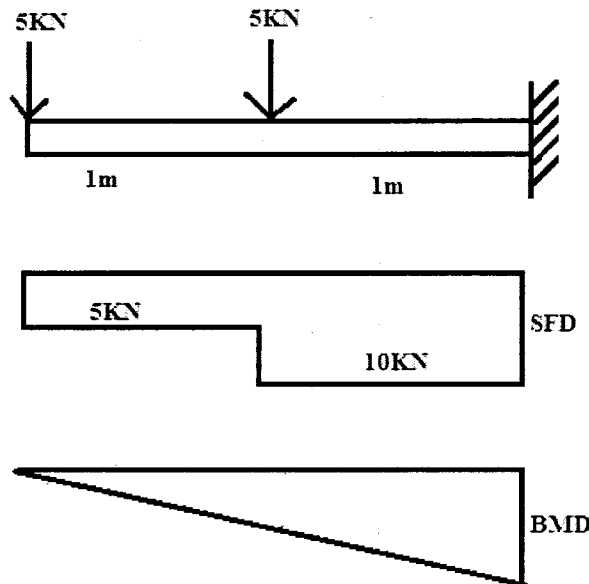
We get, Power input = $\sqrt{3}VI\cos\theta = \sqrt{3} \times 400 \times 17 \times 1 = 11777.9455$

Power Output = $\rho gHQ = 1000 \times 9.81 \times 26 \times 30 \times 10^{-3} = 7651.8$

$$\therefore \text{Efficiency} = \frac{\text{Power Output}}{\text{Power Input}} = \frac{\rho gHQ}{\sqrt{3}VI\cos\theta} = \frac{7651.8}{11777.9455} = 0.6496$$

\therefore Efficiency = 64.96% (Answer)

8. Draw the shear force and bending moment diagram of the following loaded beam.



9. What force is required to punch a 20mm diameter hole in a plate that is 25mm thick? Shear strength is 400MPa.

Solution:

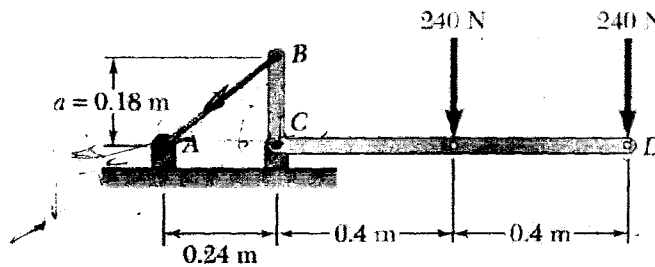
Given, $D=20\text{mm}=0.02\text{m}$; $t=25\text{mm}=0.025\text{m}$; Shear strength, $\tau=400\text{MPa}=400 \times 10^6\text{Pa}$

We get, $V = \tau A = \tau \times \pi Dt$

$$= 400 \times 10^6 \times \pi \times 0.02 \times 0.025$$

$$= 6.3 \times 10^5\text{N (Answer)}$$

10. The bracket BCD is hinged at C and attached to a cable at B. For the loading shown, determine the tension in the cable.



Solution:

We get,

$$\theta = \tan^{-1} \frac{0.18}{0.24} = 36.87^\circ$$

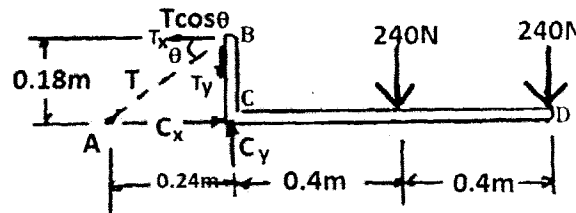
Moment at C,

$$+\circlearrowleft \sum M_C = 0$$

$$\text{or, } T \cos \theta \times 0.18 - 240 \times 0.4 - 240 \times 0.8 = 0$$

$$\text{or, } T = \frac{288}{0.18 \times \cos 36.87} = 2000 \text{ N (Ans.)}$$

Handwritten note: $240 \times 0.4 + 240 \times 0.8 = T \times 0.18 \times \cos \theta$



11. A package lift is hung in a spring scale, the package is moving downwards with an acceleration 1 m/s^2 . The tension required to hold the package is 60 N . Determine the weight of the package.

Solution:

We get,

$$mg - T = ma$$

$$\text{or, } T = mg - ma$$

$$\text{or, } T = m(g - a)$$

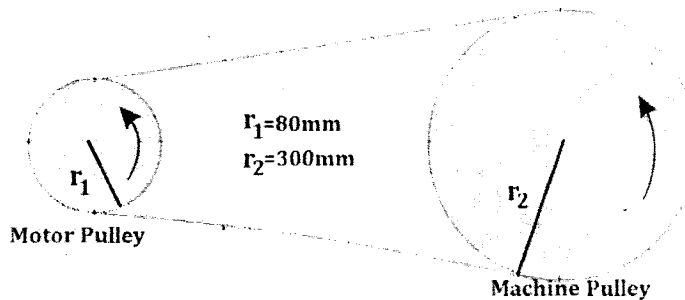
$$\text{or, } m = \frac{T}{(g - a)}$$

$$= \frac{60}{9.81 - 1} = 6.81 \text{ kg}$$

$$\therefore \text{Weight of the package} = mg = 6.81 \times 9.81 = 66.81 \text{ N (Answer)}$$



12. Two different size Pulleys (a motor pulley and a machine pulley) are connected through a flat belt. Tension at tight side and slack side are 500 N and 350 N respectively. The machine shaft has a speed of 1450 rpm . Determine the torque required and power transmitted through the machine shaft.



Solution:

Given, $T_1 = 500\text{N}$; $T_2 = 350\text{N}$; $r_2 = 300\text{mm} = 0.3\text{m}$; $N = 1450\text{rpm}$.

Torque = $(T_1 - T_2) r_2 = (500 - 350) \times 0.3 = 45\text{Nm}$ (Answer)

Power = $(T_1 - T_2) \frac{2\pi r_2 N}{60} = (500 - 350) \frac{\pi \times 2 \times 0.3 \times 1450}{60} = 6833\text{W}$ (Answer)

13. A furnace wall is build up with a refractory brick of 300mm thick and an insulating brick of 150mm, the thermal conductivities of the refractory bricks and insulating bricks are $1.5\text{ W/m}^\circ\text{C}$ and $0.5\text{ W/m}^\circ\text{C}$ respectively. The temperature of the surrounding is 40°C whereas that the furnace is 1200°C . Determine the rate heat flow per unit area.

Solution: Same as Previous year problem

14. Determine the allowable cross section area of a bar of length 2m, the maximum allowable tensile stress 150MPa and $E=200\text{GPa}$. The deformation due to tensile pull is 0.003m . [Same as BPDB-2016]

Solution:

Cannot recall the data so only solution procedure is provided:

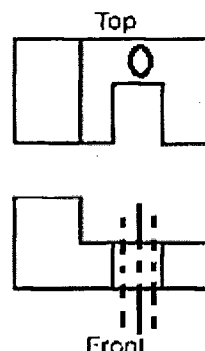
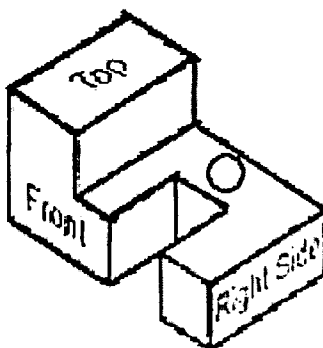
First apply this formula and find the area $\sigma = \frac{P}{A}$; Or, $A = \frac{P}{\sigma} = \frac{P}{\sigma}$

And then apply this formula and find the area,

$$\delta = \frac{PL}{AE}$$

Now, by comparing these two area values select the maximum allowable area. (Answer)

15. Draw the TOP VIEW and FRONT VIEW.



Power Grid Company of Bangladesh(PGCB)**Post: Assistant Engineer (Mechanical)****Time-10.00AM to 11.30AM****Date:02.03.2018****Exam Hall: Old Building, BUET**

1. A nuclear power plant nameplate capacity is 200MW and yearly generated power is 1625GWhr. A gas based power plant nameplate capacity is 700MW and yearly generated power is 5850GWhr. Find the plant capacity (Utilization) factor for both plants.

Solution:

For Nuclear Power Plant:

$$\text{Plant Capacity(Utilization) factor} = \frac{E}{C \times t_1}$$

$$= \frac{1625 \times 10^9}{200 \times 10^6 \times 8760} = 0.9275$$

\therefore Plant Capacity(Utilization)factor =
92.75% (Answer)

For Gas based Power Plant:

$$\text{Plant Capacity(Utilization) factor} = \frac{E}{C \times t_1}$$

$$= \frac{5850 \times 10^9}{700 \times 10^6 \times 8760} = 0.9540$$

\therefore Plant Capacity(Utilization)factor =
95.40% (Answer)

2. An IC engine develops brake horse power 7.0hp. If it consumes 50ml fuel of sp. Gr. 0.84 in 2 mins. Find the specific fuel consumption (bsfc) in g/hp-hr.

Solution:

Given, brake horse power = 7.0hp; Fuel consumption= 50ml=50×10⁻⁶m³; t=2mins= $\frac{2}{60}$ hr.

Mass of fuel=ρV = 0.84 × 1000 × 50 × 10⁻⁶ = 0.042Kg = 42gm

Specific fuel consumption (bsfc) = $\frac{\text{mass of fuel}}{\text{bhp} \times \text{time}} = \frac{42 \times 60}{7 \times 2} = 180 \text{g/hp-hr (Ans.)}$

3. An airplane was travelled at attitude 10km, speed 75km/hr. At sea level the atmospheric pressure 25KPa (abs) and temperatures was -52°C. Find the nose pressure of airplane.

Solution: Speed, v = 75km/hr = 20.83m/s; Attitude, h = 10km = 10 × 10³m; T = -52°C = (-52+273) k = 221k; R = 287j/kgK; p₁ = 2.5KPa = 2.5 × 10³.

Velocity of sound, C = $\sqrt{\gamma RT} = \sqrt{1.4 \times 287 \times 221} = 297.99 \text{m/s}$

Mach number, M = $\frac{v}{c} = \frac{20.83}{297.99} = 0.0699$.

Stag. Pressure, P₂ = P₁ [1 + $\frac{\gamma-1}{2} M^2$] ^{$\frac{\gamma}{\gamma-1}$} = 25 × 10³ [1 + $\frac{1.4-1}{2} (0.0699)^2$] ^{$\frac{1.4}{1.4-1}$}
= 25085.61pa = 25.085kpa. (Answer)

4. A 2:1 scale model of a pump was tested in a laboratory at 750rpm, head 20m and discharge 10 l/s. If the speed of prototype was 1500rpm, determine the head and discharge.

Solution: 2:1scale model means that the ratio of linear dimensions of a model and its prototype is equal = $\frac{2}{1}=2$ i.e, $\frac{D_m}{D_p}=2$.

এই প্রশ্নে একটু কনফিউশন আছে। কারণ সব সময় মডেলের linear dimension ছোট হয় আর prototype এর বড় হয়। তাই আমরা $\frac{D_m}{D_p} = \frac{1}{2}$ ধরেই সমাধান করলাম।

We get,

$$\begin{aligned} \left(\frac{\sqrt{H}}{DN}\right)_m &= \left(\frac{\sqrt{H}}{DN}\right)_p \\ \Rightarrow \frac{\sqrt{H_m}}{D_m N_m} &= \frac{\sqrt{H_p}}{D_p N_p} \\ \Rightarrow \sqrt{H_p} &= \sqrt{20 \times 2 \times \frac{1500}{750}} \\ \therefore H_p &= 320.41 \text{ m (Answer)} \end{aligned}$$

$$\begin{aligned} \text{Again, } \frac{Q_m}{D_m^3 N_m} &= \frac{Q_p}{D_p^3 N_p} \\ \Rightarrow \frac{Q_p}{Q_m} &= \left(\frac{D_p}{D_m}\right)^3 \times \frac{N_p}{N_m} \\ \Rightarrow \frac{Q_p}{Q_m} &= (2)^3 \times \frac{1500}{750} \\ \therefore Q_p &= 16 \times 10 = 160 \text{ l/s (Answer)} \end{aligned}$$

5. A large plate is fabricated from a steel alloy that has a length of crack 3mm. The fractural toughness is $80 \text{ MPa}\sqrt{\text{m}}$. Determine allowable internal stress.

Solution: [For a centre crack, length=2a and for a small edge crack, length=a] Let us consider the crack length = a.

Fractural Toughness,

$K_{Ic} = 80 \text{ MPa}\sqrt{\text{m}}$; Crack length, $a=3\text{mm}=0.003\text{m}$; Factor of safety, $n=1$;

We get, $K_{Ic} = n\sigma\sqrt{\pi a} = 1 \times \sigma\sqrt{\pi \times 0.003}$

$$\therefore \sigma = \frac{K_{Ic}}{\sqrt{\pi \times 0.003}} = \frac{80}{\sqrt{\pi \times 0.003}} = 824.05 \text{ (Answer)}$$

6. Water ($C_w = 4.2 \text{ KJ/Kg}^\circ\text{C}$) at a rate of 68 Kg/min is heated from 35°C to 75°C by oil in a counter flow double pipe heat exchanger. The oil enters the heat exchanger at 111°C and leave at 75°C . Find the amount of heat added in the water and calculate LMTD in this situation.

Solution:

Amount of heat added in the water,

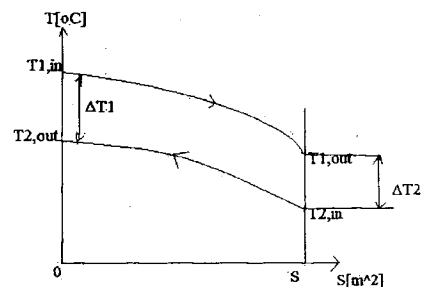
$$Q = m C_w \Delta T = \frac{68}{60} \times 4.2 \times (75 - 35) = 190.4 \text{ KJ (Answer)}$$

Here, $T_{cin} = 35^\circ\text{C}$ and $T_{cout} = 75^\circ\text{C}$, $T_{hin} = 111^\circ\text{C}$ and $T_{hout} = 75^\circ\text{C}$.

$$\Delta T_1 = T_{hin} - T_{cout} = 111 - 75 = 36$$

$$\text{and } \Delta T_2 = T_{hout} - T_{cin} = 75 - 35 = 40$$

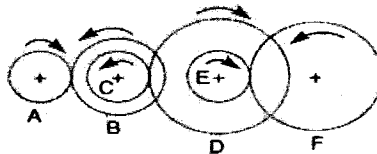
$$\therefore \text{LMTD} = \frac{\Delta T_2 - \Delta T_1}{\ln \frac{\Delta T_2}{\Delta T_1}} = \frac{40 - 36}{\ln \frac{40}{36}}$$



$$\therefore \text{LMTD} = 37.97 \approx 38^\circ\text{C or } 38\text{ K (Answer)}$$

7. The gearing of a machine tool is shown in fig. below. The motor shaft is connected to a gear A and rotates at 800 r.p.m. The gear wheels B, C, D and E are fixed to parallel shafts rotating together. The final gear F is fixed on the output shaft. What is the speed of gear F? The number of teeth on each gear are as given below

Gear	A	B	C	D	E	F
No. of Teeth	20	50	25	75	26	65



Solution:

Given: $N_A = 800$ r.p.m.; $T_A = 20$; $T_B = 50$; $T_C = 25$; $T_D = 75$; $T_E = 26$; $T_F = 65$

Let, $N_F =$ Speed of gear F i.e Last driven or follower

We know that,
$$\frac{\text{Speed of the first driver}}{\text{Speed of the last driven}} = \frac{\text{Product of no.of teeth on drivers}}{\text{Product of no.of teeth on drivers}}$$

$$\text{or, } \frac{N_A}{N_F} = \frac{50 \times 75 \times 65}{20 \times 25 \times 26} = 18.75$$

$$\therefore N_F = \frac{N_A}{18.75} = \frac{800}{18.75} = 42.67 \text{ r.p.m. (Ans.)}$$

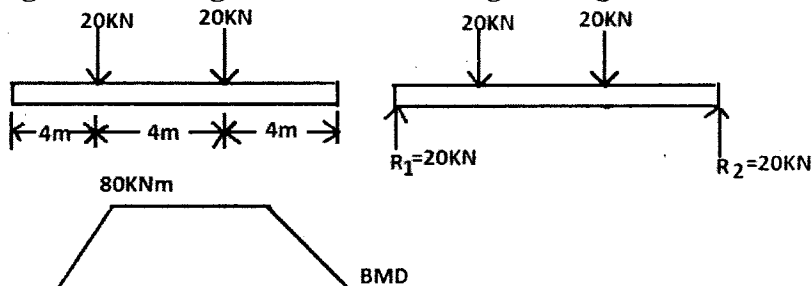
8. A refrigerator can introduce 500Kg of ice 0°C from water at 20°C in 30 mins. The latent heat of ice is 333.35KJ/Kg. Determine the tonnage capacity of the refrigeration in TOR.

Solution:

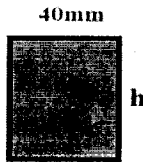
Given, $m = 500\text{Kg}$; $t = 30$ mins; $\Delta\theta = 20\text{K}$

$$\begin{aligned} \text{We get, Capacity} &= \frac{ml_f}{30} + \frac{ms\Delta\theta}{30} \\ &= \frac{500 \times 333.35}{30} + \frac{500 \times 4.2 \times 20}{30} \\ &= 6955.83 \text{ KJ/min} \\ &= 33.12 \text{ TOR (Answer)} \end{aligned}$$

9. Draw bending moment diagram of the following loading condition.



10. A cantilever of length 2 meter fails when a load of 2kN is applied at the free end. If the stress at the failure is 170MPa, then find the height of the cross section.



Solution:

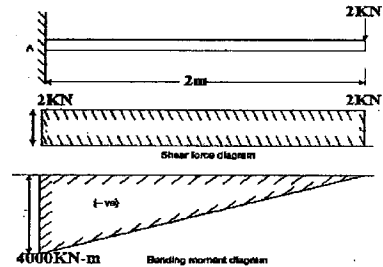
We get, moment, $M = 2 \times 2000 = 4000$

$$\therefore \sigma = \frac{M}{S} = \frac{6M}{bh^2}$$

$$\text{or, } h^2 = \frac{6M}{b\sigma}$$

$$\text{or, } h^2 = \frac{6 \times 4000}{0.04 \times 170 \times 10^6}$$

$$\therefore h = 0.05940\text{m} = 59.40 \approx 60\text{mm} \text{ (Answer)}$$



11. Two flat belts are attached with two equal size pulleys of each diameter 200mm. maximum allowable tension is 500N. Belt friction coefficient is 0.3. Determine the maximum torque of the pulley.

Solution:

Given, $T_1 = 500\text{N}$, $\mu = 0.3$, $\theta = \pi$ radian; $T_2 = ?$

We get,

$$\frac{T_1}{T_2} = e^{\mu\theta}$$

$$\Rightarrow T_2 = \frac{500}{e^{0.3 \times \pi}} = 194.83\text{N}$$

$$\text{Torque} = (T_1 - T_2) \frac{d}{2} = (500 - 194.83) \frac{0.2}{2} = 30.52\text{Nm} \text{ (Answer)}$$

12. A cylindrical shaft is under a torsional force of 100N. Inner and outer diameters of the shaft are 30mm and 50mm respectively. Determine maximum shear stress developed in the shaft.

Solution: Same as previous questions.

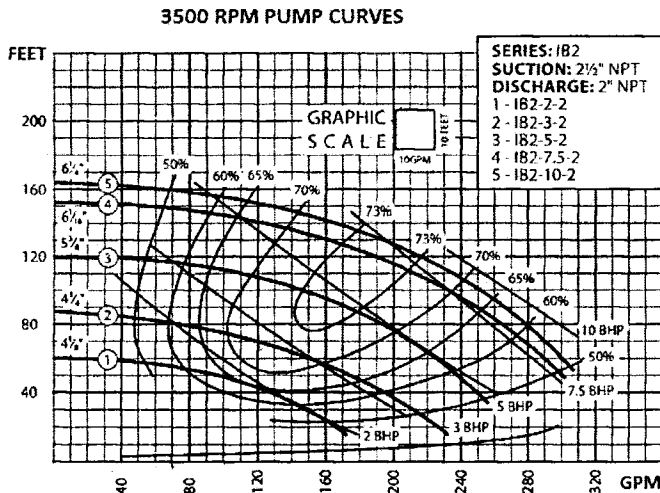
13. The speed of shaft of a steam turbine is 3000rpm and generator rotor speed is reduced at 750rpm. If the frequency of the generator is 50Hz, determine the gear ratio and number of poles of the generator.

Solution:

$$\text{Gear ratio} = \frac{3000}{750} = 4 \text{ (Ans.)}; \text{ No of poles, } P = \frac{120f}{N} = \frac{120 \times 50}{750} = 8 \text{ (Answer)}$$

Dhaka Water Supply & Sewerage Authority (DWASA)**Post: Assistant Engineer****Time 10.00AM to 11.30AM****Date: 27.10.2017****Exam Hall: BUET**Non-Departmental MCQ- $45 \times \frac{1}{3} = 15$; Departmental $13 \times 4 + 1 \times 3$ (Drawing) = 55; Total = 70.

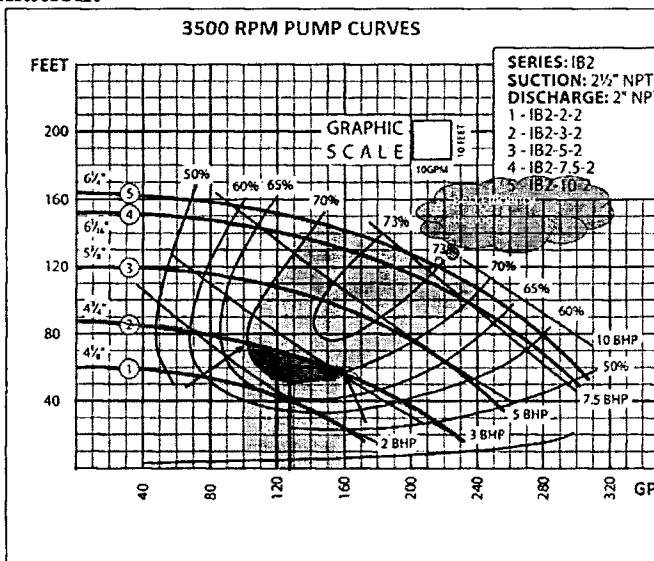
1. A typical performance curve of a centrifugal pump for various impeller diameters is given as follows at 3500rpm. For the impeller diameter $4\frac{3}{4}$ " find out the H (feet) and Q (GPM) at the operating point(s).



H(F et)	Q(GPM)

Answer:

H(Feet)	Q(GPM)
75	100
70	130
55	160

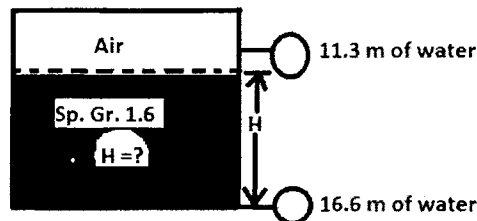
Explanation:

As no specific efficiency is mentioned, it would be wise to choose the BEP (Best Efficiency Point) for design. For High Head at BEP, choose the left point and for High flow at BEP choose the right point.

Recommendation for profession designers to design it slightly left of the Maximum efficiency point.

————— Max Efficiency Point
 ————— Operating Line

2. Find the value of H. The specific gravity of the liquid is 1.6.



$$16.6 - 11.3 = 5.3$$

$$5.3 \times 1.6 = 8.48$$

$$16.6 - 8.48 = 8.12$$

$$H = 8.12$$

Solution: Question-15, BITAC-2016

3. Draw the schematic diagram of a vapor absorption refrigeration cycle.

Answer: Question-9, BITAC-2016

4. Draw a schematic diagram of combined cycle power plant.

Answer: Question-4, BPDB-2015

5. A motorcyclist runs his vehicle on a curved path of radius 500m with a constant velocity 70 km/hr. Determine the normal and tangential component of acceleration.

Solution: Question-6, SGFCL -2017

$$a_n = \frac{v^2}{r}; a_t = \frac{dv}{dt} = 0 \text{ (for constant speed).}$$

6. A cylindrical shaft is under a torsional force of 100N-m. inside and outside dia of the shaft is 30mm and 50mm. Determine maximum shear stress of the shaft.

Solution: Question-7; NPCBL-2017

7. A flat belt is with two pulleys of equal diameter. Maximum allowable tension in the tight side is 800N. The coefficient of friction of the pulley is 0.03. Determine the maximum force in the slack side.

Solution: Question-8, NPCBL-2017

8. A 2m long pressure vessel having inner surface and outer surface temperature are 80°C and 30°C. Determine thermal stress if co-efficient of thermal expansion $\alpha = 2 \times 10^{-5} \text{ m/m}^\circ\text{C}$ and $E = 200 \text{ GPa}$.

Solution: We get,

$$\sigma = \alpha E \Delta T = 2 \times 10^{-5} \times 200 \times 10^9 \times (80 - 30) = 200 \text{ MPa (Answer)}$$

9. A spur gear having module 6mm and the teeth numbers are 10. If the speed is 1200rpm, then find the pitch line velocity.

Solution:

We know,

$$\begin{aligned} \text{Pitch line velocity} &= \frac{\pi D N}{60} \\ &= \frac{\pi \times 0.06 \times 1200}{60} \\ &= 3.76 \text{ m/s (Answer)} \end{aligned}$$

Here, module = 6mm = 0.006m

Number of Teeth, $T = 10$

$$\text{Module, } m = \frac{D}{T}$$

$$\therefore D = m \times T = 0.006 \times 10 = 0.06 \text{ m}$$

$$N = 1200 \text{ rpm}$$

10. A centrifugal pump delivers 30l/s of water at a height of 26m. A 3-phase, AC current supply to the motor voltage and current are 400V and 17A respectively. Determine the efficiency of the pump considering the power factor value is 1.

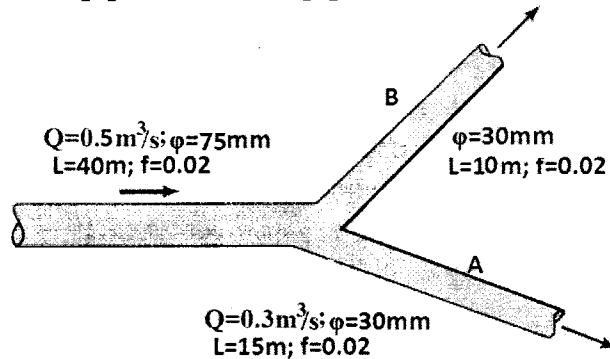
Solution: Same as Question-7, CPGCBL -2018

11. A furnace wall inside and outside temperature are 30°C and 20°C respectively has a dimension $4\text{m} \times 3\text{m} \times 0.35\text{m}$ and $K=4.5\text{W/mK}$ for the material. Determine heat flow rate per minutes.

Solution:

$$Q = kA \frac{\Delta T}{x} = 4.5 \times 4 \times 3 \times \frac{10}{0.35} = 1542.86 \text{ watt} = 92.57 \text{ KJ/min (Answer)}$$

12. Determine head loss in pipe B from the pipe network.



Solution:

We get, $Q = Q_A + Q_B$

Then, $Q_B = Q - Q_A = 0.5 - 0.3 = 0.2 \text{ m}^3/\text{s}$

$$Q = AV; V = \frac{Q}{A}$$

$$\therefore h_{fB} = \frac{fV^2}{2gd} = \frac{f\left(\frac{Q}{A}\right)^2}{2gd} = \frac{0.02 \times 10 \times \left(\frac{0.2}{\frac{\pi \times 0.03^2}{4}}\right)^2}{2 \times 9.81 \times 0.03} = 27202.26 \text{ m (Answer)}$$

13. A rectangular channel carries water at the rate of $10 \text{ m}^3/\text{s}$ and velocity 2 m/s . Determine width of the channel for most economical rectangular channel.

Solution:

We know, for most economical rectangular channel, width is two times depth of flow.

That means, $b=2h$

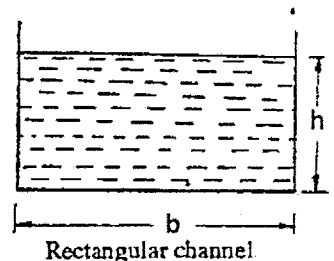
We get,

$$Q = AV; \text{ or, } Q = b \times h \times V = 2h^2 \times V$$

$$\text{or, } h^2 = \frac{Q}{2V} = \frac{10}{2 \times 2}$$

$$\text{or, } h = 1.58 \text{ m}$$

$$\therefore b = 2 \times 1.58 = 3.16 \text{ m (Answer)}$$



14. Draw TOP VIEW and Front VIEW without dimension.

Answer: Same as BITAC-2016

Non-Departmental

1. 4 stars of Bangladesh national symbol represents-4 funding principle of the present constitution of Bangladesh of 1972. These are nationalism, secularism, socialism, and democracy.

2. Who was the president of East Pakistan during 1952? Ans: Huseyn Shaheed Suhrawardy
3. Who was the finance minister of Mujibnagar government? Ans: M Munsur Ali.
4. Who was the first president of Bangladesh? Ans: Sheikh Mujibar Rahman
5. Who is the designer of the National flag? Ans: Qamrul Hasan
6. Who first hoist flag outside our country? Ans: M. Hussein Ali
7. VAT stands for-Value Added Tax
8. Where is the headquarter of Amnesty International located? Ans: London
9. When UNESCO declared Sundarbans as UNESCO world heritage site: Ans:1997
10. When was Ahsan Monjil establish? Ans:1872
11. How many brigade force was built during liberation war? Ans:3
12. When did Bangladesh enter into OIC as a member? Ans:1974
13. FIFA world cup 2018(football) will be host by- Russia
14. Elegy means- a poem of serious reflection, typically a lament for the dead
15. BIOS-Basic Input Output System
16. FTP-File Transfer Protocol
17. Binary of 25=11001
18. Where cache memory located? Ans: CPU
19. Pencils are made from-Graphite
20. Which convert AC current to DC current: Ans: Rectifier
21. The salinity of Sea water-3.5%
22. দোসরা কোন ভাষার শব্দ? উঃ হিন্দি
২৩. উক্ত এর প্রকৃতি-প্রত্যয়- বচ+ক্ত = উক্ত
২৪. মনীষা শব্দের সন্ধি বিচ্ছেদ কি? উঃ মনস্ +ঈষা
২৫. তিনি চট্টগ্রাম থেকে এসেছেন।এখানে চট্টগ্রাম কোন কারকে কোন বিভক্তি? উঃ অপাদান
২৬. মৌলিক ধাতুর অপর নাম কি? উঃ স্বয়ংক্রিয় ধাতু
২৭. কোনটি বিপ্রকর্ষের উদাহরন? উঃ সময় সময় উচ্চারণের সুবিধার জন্য সংযুক্ত ব্যঞ্জনধ্বনির মাঝখানে স্বরধ্বনি আসে। একে বলা হয় মধ্য স্বরাগম বা বিপ্রকর্ষ বা স্বরভক্তি। যেমন : অ : রত্ন>রতন, ধর্ম>ধরম, স্বপ্ন>স্বপন, হর্ষ>হরষ ইত্যাদি।
28. Four angles of a polygon are 70°,80°,90°,120°.Find the fifth angle? Ans:180°
29. In a class, there are 120 students.60% of all boys and 50% of all girls are successful in a test. If 56% of all students are girls. Find the no. of girls. Ans:68
30. He has interest in science.
31. Had you not helped him, he would have taken right decisions.
32. Which type of memory is used in a computer to store the relatively small amount of data? Ans: EEPROM
33. We eat a large number of bacteria with-yogurt

34. Public schools are good but private Schools are **better than that** of public school.
35. Neither Michele nor the board of members **intends** to attend the dean.
36. which one protects the computer from hacking?--- **firewall**
37. .The climate..... (change) rapidly nowadays. **Ans: is changing**

North West Power Generation Company Limited (NWPGL)

Post: Assistant Engineer

Time 10.00AM to 11.30AM

Date:03.11.2017

Exam Hall: BUET

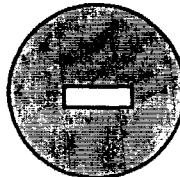
1. Draw the schematic diagram of a gas turbine with two compressors and intercooling with corresponding T-S diagram.

Solution: Same as problem-16 of APSCL-2016

2. In a pitot tube stagnation and static pressure difference is 9.8 Pa; Density of air 1.23 kg/m^3 . Calculate the velocity of flowing fluid.

Solution: Same as problem-14 of BPDB-2016

3. Find the least area moment of inertia and corresponding radius of gyration for the shaded area in the following fig. Given circle radius is 10mm and rectangular slot size is $2\text{mm} \times 5\text{mm}$.



Solution: Same as problem-9 of PGCL-2016

4. The module of a mating spur gear set is 3mm. Pressure angle 25° , number of teeth on pinion 20 and gear ratio is 3, driver pinion runs at 1500 rpm and transmits 1200W to gear. Calculate: Driving force and separating force acting on gears.

Solution: Same as problem-10 of PGCL-2016

5. Find out the efficiency for Otto cycle for the specific heat ratio (C_p/C_v) of the working fluid is considered as 1.50 and compression ratio is 10. If the cut-off ratio is 1.96 then what will be diesel cycle efficiency?

Solution: Same as problem-10 of PGCB-2017

6. An iron boiler is 10 mm thick and has a heating area 2m^2 . The two surfaces of the boiler are at 240°C and 100°C respectively. Find the mass of the water evaporated into steam per minute. Given that latent heat of steam is 536kcal/kg^{-1} and thermal conductivity of iron is $1.6 \times 10^{-2} \text{ kcal s}^{-1} \text{ m}^{-1} \text{ }^\circ\text{C}^{-1}$.

Solution: Given, $x = 10\text{mm} = 0.001\text{m}$; $A = 2\text{m}^2$; $\Delta T = 240^\circ\text{C} - 100^\circ\text{C} = 140^\circ\text{C} = 140\text{K}$;

$$K = 1.6 \times 10^{-2} \text{ kcal s}^{-1} \text{ m}^{-1} \cdot ^\circ\text{C}^{-1}; L = 536 \text{ kcal kg}^{-1}; t = 1 \text{ min} = 60 \text{ s}$$

Let m be the mass of water evaporated in steam in one minute. Then,

$$Q = mL = \frac{KA(T_1 - T_2)t}{x}$$

$$\Rightarrow m = \frac{KA(T_1 - T_2)t}{xL} = \frac{1.6 \times 10^{-2} \times 2 \times 140 \times 60}{0.001 \times 536} = 50.1 \text{ Kg (Answer)}$$

7. A cylindrical steel pressure vessel 400 mm in diameter with a wall thickness of 20 mm, is subjected to an internal pressure of 4.5 MN/m². Calculate the tangential and longitudinal stresses in the steel.

Solution: Question-8, North West Power Generation Company Limited (NWPGL)

8. A nuclear power plant name plate capacity 4000MW, its generates 32000000MWhr in a year and A Gas Turbine Power plant nameplate data capacity 400MW, it generates 1600000MWhr in a year then find capacity factor of each plant.

Solution:

For Nuclear Power Plant:

$$\begin{aligned} \text{Plant Capacity factor} &= \frac{E}{C \times t} \\ &= \frac{32000000}{4000 \times 8760} = 0.9132 \end{aligned}$$

\therefore Plant Capacity factor =
91.32% (Answer)

For Gas based Power Plant:

$$\begin{aligned} \text{Plant Capacity factor} &= \frac{E}{C \times t} \\ &= \frac{1600000}{400 \times 8760} = 0.4566 \end{aligned}$$

\therefore Plant Capacity factor =
45.66% (Answer)

9. Determine refrigeration capacity in ton when $m=500$ kg temperature falls from 20°C to 0°C in 50 minutes.

$$\text{Solution: Capacity} = \frac{ms\Delta T}{t} = \frac{500 \times 4.2 \times 20}{50 \times 60} = 14 \text{ KW} = 4 \text{ ton}$$

10. Find the head of a centrifugal pump from water surface when head loss 1 m and NPSH 4 m. Take Vapor pressure head 0.4m.

Solution: We get, $\text{NPSH} = (H - h_f) - P_v$; or, $H = 4 + 1 + 0.4 = 5.4 \text{ m (Answer)}$

11. Mohr circle related math, Find principal stress and draw the Mohr Circle.

12. Sectional Drawing.

Non-Departmental

- পরীক্ষা এর সন্ধি বিচ্ছেদ-পরি+ঈক্ষা
- চলতি এর প্রত্যয় কোনটি? উঃ $\sqrt{\text{চল}} + \text{তি} = \text{চলতি}$
- উলুখাগড়া এর অর্থ কি? উঃ তুচ্ছ ব্যক্তি
- পাথুরে মূর্তি -উপাদানবাচক বিশেষণ
- দুটো সমবর্ণের একাটির পরিবর্তনকে কি বলে - বিষমীভবন
- দফতর কোন ভাষার শব্দ? - ফারসি শব্দ
- A train of length 130m passes as platform at a speed of 45km/hr in 30 see, find out floor length??? Answer: 245m

8. If $x\%$ of $y = 200$ and $y\%$ of $z = 400$ then find the relation between z and x . **Ans:** $x = \frac{z}{2}$
9. Calculate area of trapezium
10. Calculate area of an arc segment
11. শেখ মুজিবুর রহমান কবে বাংলাদেশের প্রধানমন্ত্রী হন? উঃ ১২ জানুয়ারী ১৯৭২
12. NWPGL কবে প্রতিষ্ঠিত হয়? উঃ 28 August, 2007
13. বর্তমানে NWPGL এ কয়টা প্লান্ট আছে? উঃ ৩টি (সিরাজগঞ্জ, খুলনা, ভেড়ামারা)
14. Which one has test bud? **Answer: butterfly.**
15. আগরতলা ষড়যন্ত্র মামলা প্রত্যাহার হয় কবে? উঃ ২২ ফেব্রুয়ারী ১৯৬৯
16. পদ্মা সেতুর অপর স্প্যান বসে কবে? উঃ ৩য় স্প্যান (১১ মার্চ, ২০১৮)
17. জন ন্যাস কে নিয়ে কোন মুভি? উঃ A beautiful Mind
18. মরিচে কোন উপাদান থাকে? উঃ Capsaicin ($C_{18}H_{27}O_3N$)
19. ভিনেগার কোনটা? উঃ ভিনেগার এসিটিক এসিডের (CH_3COOH) ৬-১০% ও পানির মিশ্রণে তৈরি
20. বাংলাদেশে বর্তমান জেনারেশন ক্ষমতা কত?
বেজ লোড প্ল্যান্ট কোনগুলো? উঃ coal-fired power plant, geothermal power plant, tidal power plant, nuclear power plant, etc

Gas Transmission Company Limited (GTCL)

Post: Assistant Engineer

Time 10.00AM to 11.30AM

Date: 30.03.2018

Exam Hall: BUET

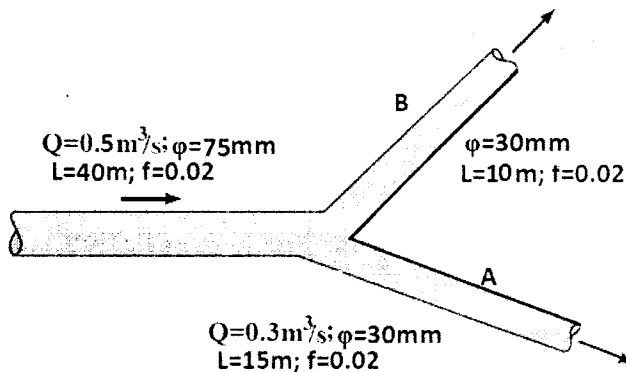
1. Gas flows at the rate of $0.05 \text{ m}^3/\text{min}$ at 30°C and 202 KPa . Determine the volume flow rate at atmospheric condition. Assume atmospheric pressure is 101 KPa and temperature is 25°C .

Solution: Similar to Problem-05 of SGCL-2017

N.B.: as it denotes gas flow so it also can be use isentropic/adiabatic process.

Reference problem: Thermal engineering by Khurmi- 2.1

2. Determine head loss in pipe B from the pipe network.

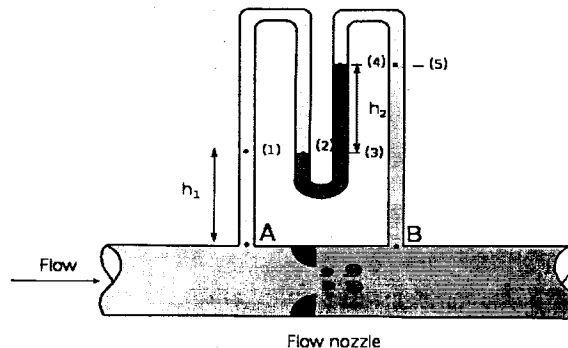


Solution: Similar to Problem-12 of DWASA-2017

3. A 250 KW engine has a thermal efficiency of 42.2%. If the calorific value of the fuel is 40.3 MJ/Kg, determine a) Input power of the engine b) specific fuel consumption of the engine in Kg/KWh.

Solution: Similar to Problem-04 of SGCL-2017

4. Develop an expression for the pressure difference ($\Delta P = P_A - P_B$).



Solution:

Equating the pressure across the line of point -4,

We get,

$$P_A - h_1\gamma_1 - h_2\gamma_1 + h_2\gamma_2 = P_B - h_1\gamma_1 - h_2\gamma_1$$

$$\therefore P_A - P_B = h_2(\gamma_2 - \gamma_1) \text{ (Answer)}$$

5. A gas pipe line with a nominal dia of 500 mm and a thickness of 24 mm, delivers 1 Mm³/day (at standard conditions). If the gas is supplied at 100bar and 25°C temperature with a viscosity of 0.00012 poise. Find the Reynolds number

Solution: $D_N = 500\text{mm}$

Let, $D_N = D_0$ [as D_N is more than 1in]; $\mu = 0.00012 \text{ Poise} = 0.000012 \text{ Ns/m}^2$

$$\therefore Q = 1 \text{ Mm}^3/\text{day} = 1 \times 10^6 \text{ m}^3/\text{day}$$

$$\therefore D_i = 500 - (2 \times 24) = 452 \text{ mm}$$

$$Q = AV \Rightarrow V = \frac{Q}{A} = \frac{1 \times 10^6}{24 \times 3600 \times \frac{\pi}{4} \times D_i^2} = \frac{1 \times 10^6 \times 4}{24 \times 3600 \times \pi \times (0.452)^2} \quad \therefore V = 72.13 \text{ ms}^{-1}$$

$$P = \rho RT \Rightarrow \rho = \frac{P}{RT} = \frac{100 \times 101325}{295 \times 298} = 115.26 \text{ kg/m}^3 \text{ [As no specific gas is mentioned so, Assuming } R = 295 \text{ J/KgK]}$$

$$\therefore Re_N = \frac{\rho V D_i}{\mu} = \frac{115.26 \times 72.13 \times 0.452}{0.000012} = 313.14 \times 10^6 \text{ (Answer)}$$

6. A centrifugal pump delivers 0.05 m³/s of water to a height of 15.8m through a 15cm diameter pipe and 100m long. The hydraulic and manometreic efficiencies are 74% and 86% respectively. Find the power required to drive the pump. Take friction factor co-efficient, $f=0.05$.

Solution:

$$\text{We get, } V_s = V_d = V = \frac{Q}{A} = \frac{0.05}{\frac{\pi}{4} \times (0.15)^2} = 2.829 \text{ m/s}$$

$$\eta_0 = \eta_{\text{man}} \times \eta_h = 0.86 \times 0.74 = 0.6364$$

$$\begin{aligned}
 \therefore H_m &= (h_s + H_d) + (h_{fs} + h_{fd}) + \frac{V_d^2}{2g} \\
 &= H + \frac{fLV^2}{2gd} + \frac{V_d^2}{2g} \\
 &= 15.8 + \frac{0.05 \times 100 \times (2.829)^2}{2 \times 9.81 \times 0.15} + \frac{(2.829)^2}{2 \times 9.81} = 29.8 \text{ m} \\
 \therefore P &= \frac{\rho g Q H_m}{\eta} = \frac{9810 \times 0.05 \times 29.8}{0.6364} = 22.968 \text{ KW (Answer)}
 \end{aligned}$$

7. Discharge pressure of an air compressor is 2000Psig & inlet pressure 100Psig. How many compressors will be needed if the compression ratio is between 3 to 5?

Solution: Given,

Inlet pressure, $P_1 = 100 \text{ Psig}$, Discharge pressure, $P_{n+1} = 2000 \text{ Psig}$

Compression ratio, $\frac{P_{n+1}}{P_n} = 3 \text{ to } 5$

Taking $\frac{P_{n+1}}{P_n} = 3$

$$\text{or, } \frac{P_{n+1}}{P_n} = \left(\frac{P_{n+1}}{P_1} \right)^{\frac{1}{n}}$$

$$\text{or, } 3 = \left(\frac{2000}{100} \right)^{\frac{1}{n}}$$

$$\text{or, } \log 3 = \frac{1}{n} \times \log 20$$

$$\therefore n = 2.726 \approx 2$$

\therefore Number of compressors is 2 (Answer)

Again, taking $\frac{P_{n+1}}{P_n} = 5$

$$\text{or, } \frac{P_{n+1}}{P_n} = \left(\frac{P_{n+1}}{P_1} \right)^{\frac{1}{n}}$$

$$\text{or, } 5 = (20)^{\frac{1}{n}}$$

$$\text{or, } \log 5 = \frac{1}{n} \times \log 20$$

$$\therefore n = 1.80 \approx 2$$

N.B.: This problem is similar to the Question-08 of BGFCL-2017. This is another possible solution.

8. In a certain double pipe heat exchanger hot water flows at a rate of 5000 kg/h and gets cooled from 95°C to 65°C. At the same time 50000 kg/h of cooling water at 30°C enters the heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at 2270 W/m² K. Determine the temperature of water at outlet condition. Assume for the both the streams $c_p = 4.2 \text{ kJ/kg K}$. [similar, data are not same]

Solution: Given: $\dot{m}_h = \frac{5000}{3600} = 1.389 \text{ kg/s}$; $t_{h1} = 95^\circ\text{C}$; $t_{h2} = 65^\circ\text{C}$;

$$\dot{m}_c = \frac{50000}{3600} = 13.89 \text{ kg/s}; t_{c1} = 30^\circ\text{C}; U = 2270 \text{ W/m}^2 \text{ K};$$

$$c_{ph} = c_{pc} = 4.2 \text{ kJ/kg or } 4200 \text{ J/kg K}$$

$Q = \text{Heat lost by hot water} = \text{Heat gained by cold water}$

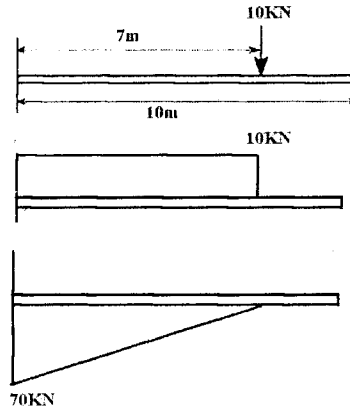
$$\dot{m}_h c_{ph} \times (t_{h1} - t_{h2}) = \dot{m}_c c_{pc} \times (t_{c2} - t_{c1})$$

$$\Rightarrow 1.389 \times 4200 \times (95 - 65) = 13.89 \times 4200 \times (t_{c2} - 30)$$

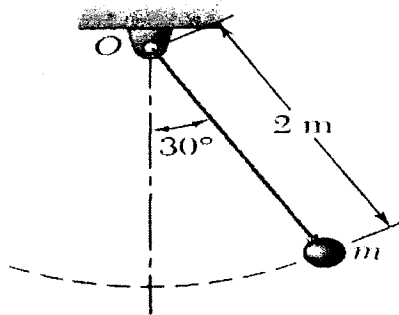
$$\Rightarrow 30 = 10 \times (t_{c2} - 30)$$

$$\therefore t_{c2} = 33^\circ\text{C (Answer)}$$

9. Draw SFD and BMD.



10. The bob of a 2m simple pendulum describes an arc of circle in a vertical plane. If the tension in the cord is 2.5 times the weight of the bob for the position shown, find the acceleration of the bob at the position.



Solution:

$$\sum F_t = ma_t$$

$$\text{Or, } mg \sin 30^\circ = ma_t$$

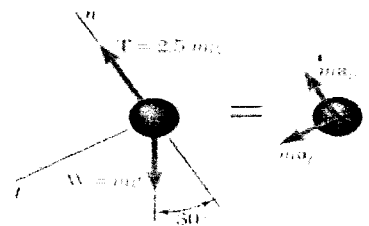
$$\therefore a_t = g \sin 30^\circ = 9.81 \times \sin 30^\circ = 4.9 \text{ m/s}^2$$

(Answer)

$$\sum F_n = ma_n$$

$$\text{Or, } 2.5mg - mg \cos 30^\circ = ma_n$$

$$\therefore a_n = 2.5g - g \cos 30^\circ = 16.03 \text{ m/s}^2 \text{ (Answer)}$$



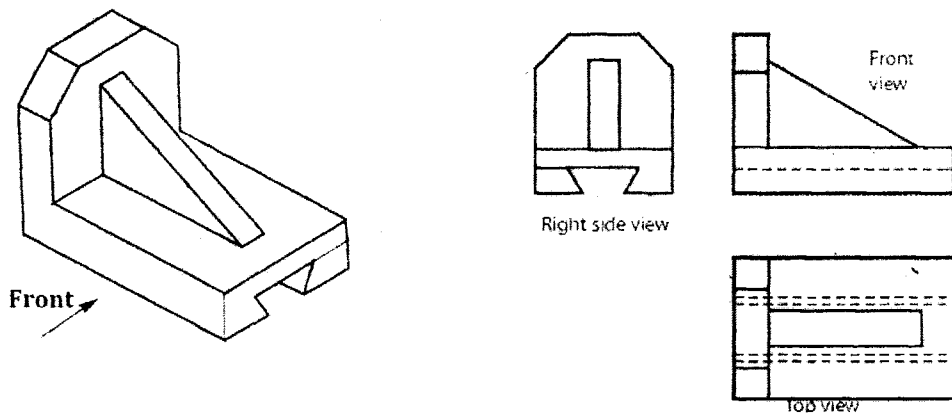
11. The flywheel of a steam engine has a radius of gyration of 0.5m and mass 300kg. The starting torque of the engine is 1000 N-m. Determine angular acceleration of the flywheel.

Solution: $\tau = I\alpha$

$$\text{Or, } \alpha = \frac{\tau}{I} = \frac{\tau}{mk^2} = \frac{1000}{300 \times (0.5)^2} = 13.33 \text{ rad/s}^2 \text{ (Answer)}$$

12. Same as problem-08 of DWASA-2017.

13. Draw the TOP VIEW and FRONT VIEW.



Titas Gas Transmission and Distribution Company Limited

Post: Assistant Engineer (Mechanical)

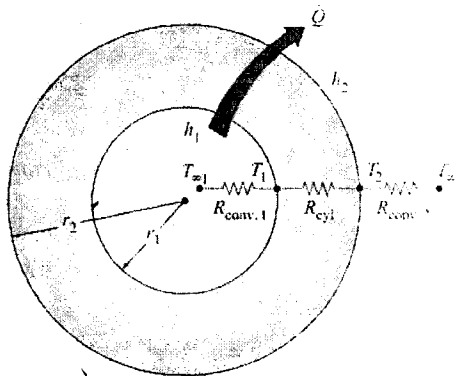
Date: 27.04.2018

Exam Hall: BUET

Total Marks-20(Analytical)+30(GK)+50(Dept.)=100

1. A pipe has inner and outer radius of r_1 & r_o and a fluid is passing through it with heat transfer co-efficient h_1 , Surrounding air heat transfer co-efficient is h_o , thermal conductivity and length of pipe is K and L , If area is A then draw the thermal resistance network and write down the equation of heat loss.

Solution:



$$R_{\text{total}} = R_{\text{conv.1}} + R_{\text{cyl}} + R_{\text{conv.2}}$$

$$= \frac{1}{(2\pi r_1 L) h_1} + \frac{\ln\left(\frac{r_2}{r_1}\right)}{2\pi L k} + \frac{1}{(2\pi r_2 L) h_2}$$

$$Q = \frac{T_{\alpha 1} - T_{\alpha 2}}{R_{\text{total}}}$$

2. In a vapor compression refrigeration system enthalpy at suction of compressor is 192 KJ/Kg and enthalpy at exit port of compressor is 212 KJ/Kg and enthalpy at the entry port of evaporator is 81 KJ/Kg. Determine the COP of this system.

Solution:

From the p-h diagram,

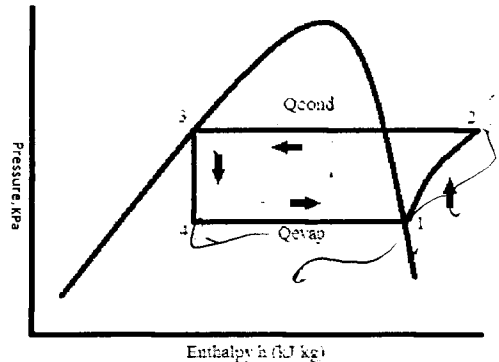
h_1 = enthalpy at suction of compressor = 192 KJ/Kg

h_2 = enthalpy at exit port of compressor = 212 KJ/Kg

h_4 = enthalpy at the entry port of evaporator = 81 KJ/Kg

We know, $COP = \frac{\text{Refrigeration effect}}{\text{Compressor work}}$

$$= \frac{h_1 - h_4}{h_2 - h_1} = \frac{192 - 81}{212 - 192} = \frac{110}{20} = 5.5 \text{ (Answer)}$$



3. Determine the LMTD for the following heat exchanger.

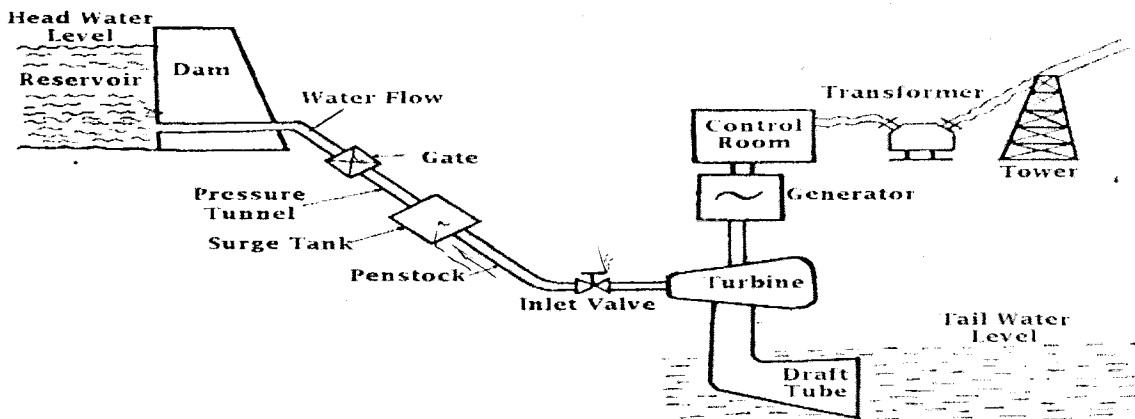
Solution: Same as previous year question.

4. Why draft tube is used in hydro-electric power plant? Show its position in a hydroelectric power plant with sketch.

Answer:

The main functions of draft tube is

- To allow the installation of turbine above the tail race level without loss of head and
- To convert major part of kinetic energy coming out of runner into pressure energy.



5. Define viscosity? Write down Newton's law of viscosity.

Answer: See at Page (3-1 of fundamentals of mechanical engineering book volume-1)

6. Draw block diagram of Rankine cycle showing different processes name. Draw its corresponding T-S diagram.

Solution: Same as previous year question.

7. A pump delivers $0.050 \text{ m}^3/\text{s}$ water to a total height of 15 m. Length and diameter of pipe is 20m and 155 mm respectively. Overall efficiency of the pump is 65%. Find the power required to drive the pump. Take friction factor co-efficient $f = 0.054$.

Solution: Same as PGCB-2017

8. Write down the test name for following properties of material.

Answer:

Properties	Test Name
Ductility	Bend test.
Toughness	Charpy Test or Izod impact test.
Endurance limit	Constant amplitude test, Variable amplitude test/ cyclic loading test

9. Determine the elongation (mm) for the following spring conditions.

Solution: Given data, $k_1 = 2 \text{ KN/m}$, $k_2 = 8 \text{ KN/m}$

Spring system-1(series),

$$\frac{1}{k_s} = \frac{1}{k_1} + \frac{1}{k_2}$$

$$\Rightarrow \frac{1}{k_s} = \frac{1}{2} + \frac{1}{8} = \frac{5}{8}$$

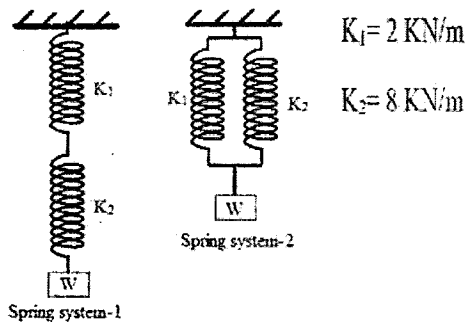
$$\Rightarrow k_s = \frac{8}{5} \text{ KNm}^{-1} = \frac{8}{5} \text{ Nmm}^{-1}$$

Spring system-2(parallel),

$$K_p = K_1 + K_2 = 2 + 8$$

$$\Rightarrow K_p = 10 \text{ KNm}^{-1}$$

$$= 10 \text{ Nmm}^{-1}$$



Spring System

1 \Rightarrow series

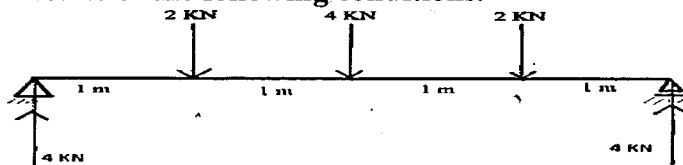
2 \Rightarrow parallel

Extensions (mm)

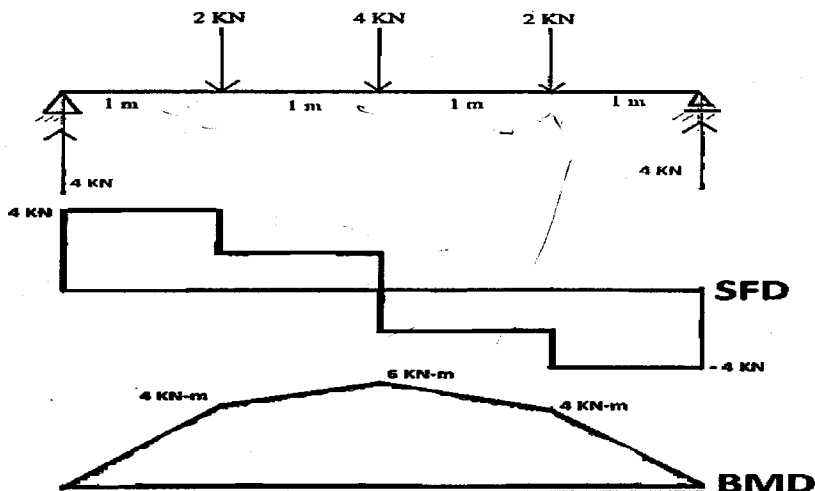
$$x_1 = \frac{F}{k_s} = \frac{W}{\frac{8}{5}} = \frac{5W}{8} \text{ mm}$$

$$x_2 = \frac{F}{k_s} = \frac{W}{10} = \frac{W}{10} \text{ mm}$$

10. Write down the results of the following conditions.

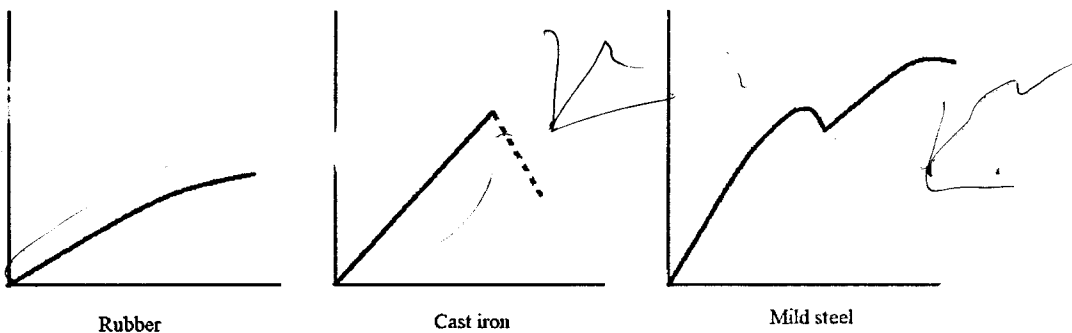


Solution:



Conditions	Results
Reactions at the end	4 kN 4 kN
Max. shear force	4 kN Max.
Bending moment	6 kN-m

11. Draw the load vs. deflection curve for the following materials: rubber, cast iron and mild steel in a tension test.



12. Write down the difference in table for Welding, soldering & Brazing.

	Welding	Soldering	Brazing
Similar/ dissimilar	Similar/ dissimilar	dissimilar	Similar
Temp. range	900~3800 °C	< 450 °C	450~900 °C

13. The following table contains some operations. Write down the name of the tools used to perform those operations.

Operations	Machine Tools Name
Shaping perfectly circular work piece	Lathe
Shaping perfectly rectangular work piece	Shaper
Surface finishing of metal	Grinder
Milling, boring & drilling	Drill Press

14. A spur gear having diameter 400 mm & teeth no 50, Determine the following parameters.

Solution: Diameter, $D = 400$ mm Teeth no, $T = 50$

Circular Pitch, P_c	$P_c = \pi m = \frac{\pi D}{T} = \frac{\pi \times 400}{50} = 8\pi$
Diametric pitch (P_d)	$P_d = \frac{1}{m} = \frac{T}{D} = \frac{50}{400} = \frac{1}{8}$
Module (m)	$m = \frac{D}{T} = \frac{400}{50} = 8$

15. A pressure vessel of 60 mm inner diameter has thickness of 2 mm. Determine the bursting pressure when strength of vessel material is 350 MN/m^2 .

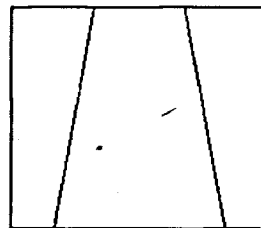
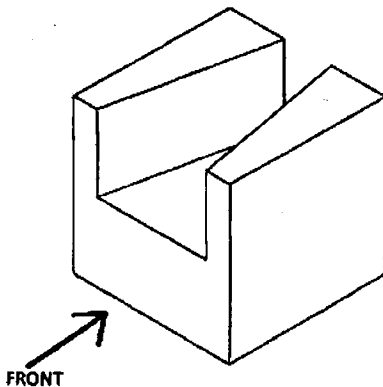
Solution: Since, such type of pressure vessel fails at hoop stress, so bursting pressure can be determined from hoop stress formula.

$$\sigma_t = \frac{PD}{2t}$$

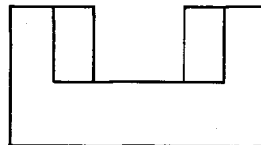
$$\Rightarrow 350 = \frac{P \times 60}{2 \times 2}$$

$$\therefore P = 23.33 \text{ MPa (Answer)}$$

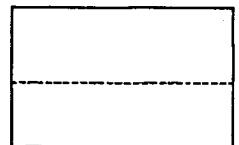
16. Draw TOP VIEW, Front VIEW and RHS VIEW.



TOP VIEW



FRONT VIEW



RHS VIEW

Jamuna Oil Company Ltd.

Post: Assistant Engineer (Mechanical)

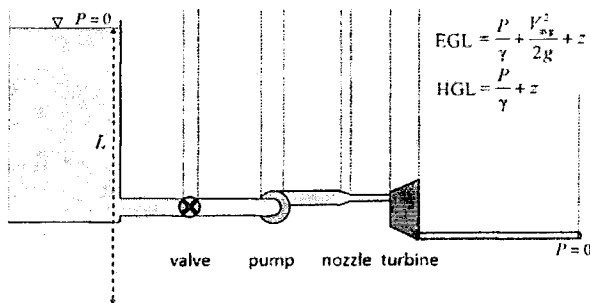
Date: 05.07.2018

Exam Time: 3.30 PM - 5.00 PM

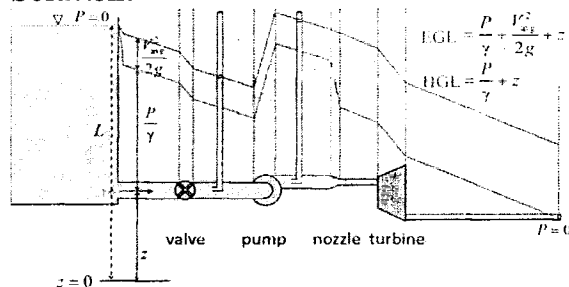
Exam venue: BUET

Total Marks – 25(Non-Dept. MCQ)+50(Written Dept.) = 75

1. For the following hydraulic block diagram draw energy gradient line (EGL) & Hydraulic gradient line (HGL).



Solution:



2. For pipe flow having diameter 8 cm, flow rate 15L/s, length of pipe 20 m, specific weight 0.8 then find head loss in KPa and determine the flow whether it is laminar or turbulent ? $f = 0.0032$

Solution: Given, Dia, $d = 8 \text{ cm} = 0.08 \text{ m}$; flow rate, $Q = 15 \text{ L/s} = 0.015 \text{ m}^3/\text{s}$; length, $l = 20 \text{ m}$; sp. wt. = 0.8; density, $\rho = 1000 \times 0.8 = 800 \text{ Kg/m}^3$; $f = 0.0032$; $H_f = ?$

We know,

$$Q = AV \Rightarrow V = \frac{Q}{A} = \frac{Q}{\frac{\pi d^2}{4}} = \frac{0.015}{\frac{\pi \times (0.08)^2}{4}} = 2.984 \text{ m/s}$$

$$\text{Head loss, } H_f = \frac{f l V^2}{2 g d} = \frac{0.0032 \times 20 \times 2.984^2}{2 \times 9.81 \times 0.08} = 0.363 \text{ m}$$

$$\text{Head loss in KPa, } H_f = \frac{H_f \rho g}{1000} = \frac{0.363 \times 800 \times 9.81}{1000} = 2.85 \text{ KPa (Answer)}$$

To know flow type we have to determine Reynolds number, which is a function of viscosity of that fluid. Viscosity is not given. Assume $\mu = 0.00164 \text{ Pa.s}$

$$\therefore \text{Re} = \frac{\rho V D}{\mu} = \frac{0.8 \times 1000 \times 2.984 \times 0.08}{0.00164} = 116448$$

So, the flow is turbulent. **(Answer)**

3. If area of a square pipe and a circular pipe is same; flow density, velocity and viscosity are also same then in which pipe Reynolds number will be larger?

Solution: We get, Reynolds number, $\text{Re} = \frac{\rho v D}{\mu}$; Since area, density, velocity and viscosity of a square and circular pipe is same then Reynolds will vary only for hydraulic diameter = D .

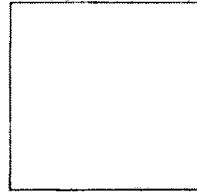
Hydraulic diameter for square,

$$D = \frac{4 \times \text{cross sectional area}}{\text{wetted perimeter}} = \frac{4 \times A}{P} = \frac{4 \times a^2}{4a} = a$$

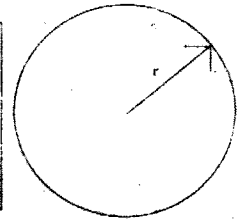
$$= \sqrt{\pi r^2} = 1.77248r$$

Hydraulic diameter for circular pipe,

$$D' = \frac{4 \times \text{cross sectional area}}{\text{wetted perimeter}} = \frac{4 \times A}{P} = \frac{4 \times \pi r^2}{2\pi r} = 2r$$



$$A = a^2 = \pi r^2$$



$$A = \pi r^2$$

As the hydraulic diameter for circular pipe ($=2r$) is greater than the hydraulic diameter for square pipe ($=1.77248r$) So Reynolds number for circular pipe will be greater.

4. Write down the three dimensional heat transfer equation in Cartesian co-ordinates & state the equations for its different boundary conditions.

Answer: Three dimensional heat conduction equation in Cartesian co-ordinates is

$$\frac{\delta^2 T}{\delta x^2} + \frac{\delta^2 T}{\delta y^2} + \frac{\delta^2 T}{\delta z^2} + \frac{\dot{q}}{k} = \frac{1}{\alpha} \cdot \frac{\delta T}{\delta t}$$

Handwritten note: $\frac{4\pi r^2}{2\pi r}$

Where, k = thermal conductivity and α = thermal diffusivity = $\frac{k}{\rho C}$

1. Steady state (Poisson equation)	$\frac{\delta^2 T}{\delta x^2} + \frac{\delta^2 T}{\delta y^2} + \frac{\delta^2 T}{\delta z^2} + \frac{\dot{q}}{k} = 0$
2. Transient, no heat generation (Diffusion Equation)	$\frac{\delta^2 T}{\delta x^2} + \frac{\delta^2 T}{\delta y^2} + \frac{\delta^2 T}{\delta z^2} = \frac{1}{\alpha} \cdot \frac{\delta T}{\delta t}$
3. Steady state, no heat generation (Laplace equation)	$\frac{\delta^2 T}{\delta x^2} + \frac{\delta^2 T}{\delta y^2} + \frac{\delta^2 T}{\delta z^2} = 0$

5. A pressure vessel having diameter 400 mm, internal pressure 50 MPa, Maximum value of tangential and longitudinal stress is 140 MPa and 190 MPa respectively, find out the thickness of the pressure vessel.

Solution: Given, $D = 400$ mm; $P = 50$ MPa; $\sigma_t = 140$ MPa; $\sigma_L = 190$ MPa; thickness, $t = ?$

Here, tangential stress, $\sigma_t = \frac{PD}{2t}$

Longitudinal stress, $\sigma_L = \frac{PD}{4t}$

$$t = \frac{PD}{2\sigma_t} = \frac{50 \times 400}{2 \times 140} = 71.42 \text{ mm}$$

$$t = \frac{PD}{4\sigma_L} = \frac{50 \times 400}{4 \times 190} = 26.32 \text{ mm}$$

\therefore Safe thickness for the pressure vessel = 71.42 mm (**Answer**)

6. Draw the T-s diagram of a vapor compression refrigeration cycle. Calculate COP of the bellow p-h diagram.

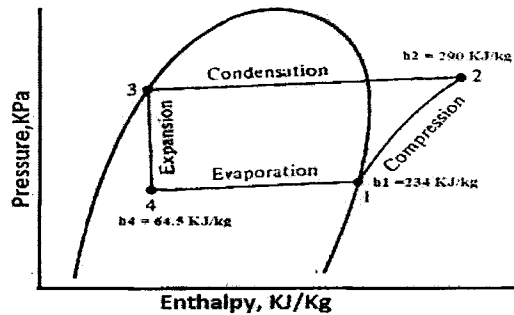
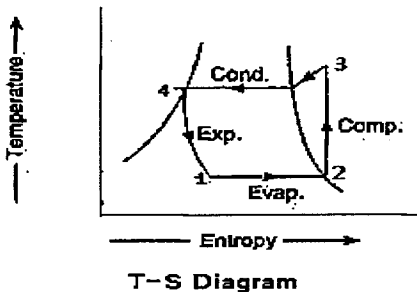
Solution: From P-h diagram,

h_1 = enthalpy at suction of compressor = 234 KJ/Kg

h_2 = enthalpy at exit part of compressor = 290 KJ/Kg

h_4 = enthalpy at the entry port of evaporator = 65.5 KJ/Kg





$$\therefore \text{COP} = \frac{\text{cooling effect}}{\text{compressor work}} = \frac{h_1 - h_4}{h_2 - h_1} = \frac{234 - 65.5}{290 - 234} = \frac{168.5}{56} = 3.0089 \text{ (Answer)}$$

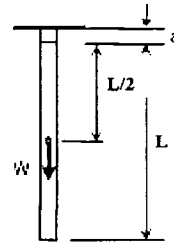
7. Derive the equation for elongation of bar due to its own weight hanging vertically having length L , mass m , area A , modulus of elasticity E .

Solution:

As the Self weight works on centroid of the bar then for elongation active length will be half of the total length. Length for elongation $L' = L/2$

Load = $W = mg$

$$\begin{aligned} \text{We get, elongation, } \delta &= \frac{PL'}{AE} \\ &= \frac{mg L/2}{AE} = \frac{mgL}{2AE} \end{aligned}$$



8. A parallel flow pipe heat exchanger is to heat water by ethanol of 10000 Kg/hr from 64.5°C to 38.2°C having specific heat 1905 J/Kg.K. Water at a rate of 7000 Kg/hr is heated. If water enter at 8°C and have specific heat 4180 J/Kg.K then find out the exit temperature of water & LMTD.

Solution:

Given, $m_e = 10000 \text{ Kg/hr}$; $T_{e,in} = 64.5^\circ\text{C} = 64.5 + 273 = 337.5 \text{ K}$; $T_{e,out} = 38.2^\circ\text{C} = 38.2 + 273 = 311.2 \text{ K}$;
 $\Delta T_e = T_{e,in} - T_{e,out} = 337.5 - 311.2 = 26.3$; $S_e = 1905 \text{ J/Kg.K}$; $m_w = 7000 \text{ Kg/hr}$; $T_{w,in} = 8^\circ\text{C}$
 $= 8 + 273 = 281$; $\Delta T_w = T_{w,out} - T_{w,in} = t - 281$; $S_w = 4180 \text{ J/Kg.K}$; $T_{w,out} = t = ?$ LMTD = ?

Heat released by ethanol = Heat absorbed by water

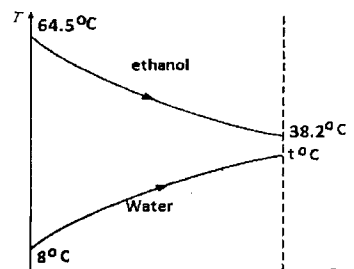
$$\begin{aligned} m_e S_e \Delta T_e &= m_w S_w \Delta T_w \\ \Rightarrow 10000 \times 1905 \times 26.3 &= 7000 \times 4180 \times (t - 281) \\ \Rightarrow t &= 281 + \frac{10000 \times 1905 \times 26.3}{7000 \times 4180} = 281 + 17.1 = 298.1 \text{ K} \end{aligned}$$

$\therefore t = 298.1 \text{ K} = 25.1^\circ\text{C}$ (Answer);

Again, $\Delta T_1 = 64.5 - 8 = 56.5$; $\Delta T_2 = 38.2 - 25.1 = 13.1$

We get,

$$\text{LMTD} = \frac{\Delta T_1 - \Delta T_2}{\ln \frac{\Delta T_1}{\Delta T_2}} = \frac{56.5 - 13.1}{\ln \frac{56.5}{13.1}} = 29.7 \text{ (Answer)}$$



9. A steel pipe is under load of 2000N; length of the bar is 2m and is under maximum stress of 150MPa. For that condition maximum deflection is 30 mm, then find the required diameter. $E=200\text{GPa}$.

Solution: Given, $P = 2000\text{ N}$; $L = 2\text{ m}$; $\sigma_{\max} = 150\text{ MPa}$; $\delta_{\max} = 30\text{ mm}$; $E = 200\text{ GPa}$; diameter, $d = ?$

We know, $\sigma_{\max} = \frac{P}{A} = \frac{P}{\pi D^2/4}$

$$\Rightarrow D = \sqrt{\frac{4P}{\pi \times \sigma_{\max}}} = \sqrt{\frac{4 \times 2000}{\pi \times 150 \times 10^6}} = 4.12\text{mm}$$

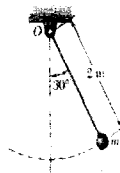
Again,

$$\delta_{\max} = \frac{PL}{AE} = \frac{PL}{\frac{\pi D^2}{4E}}$$

$$\Rightarrow D = \sqrt{\frac{4PL}{\pi E \delta_{\max}}} = \sqrt{\frac{4 \times 2000 \times 2 \times 1000}{\pi \times 200 \times 10^9 \times 30}} = 0.92\text{mm}$$

\therefore Required diameter = 4.12 mm (Answer)

10. The bob of a 2m simple pendulum describes an arc of circle in a vertical plane. If the tension in the cord is 2.5 times the weight of the bob for the position shown, find the velocity of the bob at that position.



Solution:

$$\sum F_n = ma_n$$

$$\Rightarrow 2.5mg - mg \cos 30^\circ = ma_n$$

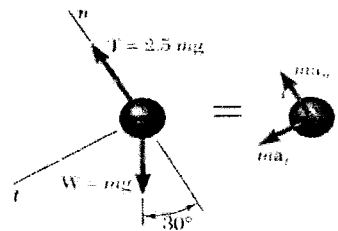
$$\therefore a_n = 2.5g - g \cos 30^\circ = 16.03\text{m/s}^2$$

$$\text{Again, } a_n = \frac{v^2}{r}$$

$$\Rightarrow v = \sqrt{a_n \times r}$$

$$\Rightarrow v = \sqrt{16.03 \times 2}$$

$$\Rightarrow v = 5.66\text{ m/s (Answer)}$$



11. For a belt system initial pull is 2500N, angle of smaller pulley is 150 degree, coefficient 0.25, velocity 6.5 m/s. then find the power transmitted.

Answer: Given, $T_1 = 2500\text{ N}$; $\theta = 150^\circ = 150 \times \frac{\pi}{180}$; $\mu = 0.25$; $V = 6.5\text{ m/s}$; Power, $p = ?$

We get,

$$\text{Initial Tension, } T_1 = \frac{T_1 + T_2}{2},$$

$$\Rightarrow 2500 = \frac{T_1 + T_2}{2},$$

$$\therefore T_1 + T_2 = 5000 \dots \dots \dots (i)$$

$$\text{Again, } \frac{T_1}{T_2} = e^{\mu \theta}$$

$$\Rightarrow T_2 = \frac{T_1}{e^{\mu \theta}} = \frac{T_1}{e^{0.25 \times 150 \times \frac{\pi}{180}}} = \frac{T_1}{1.9242}$$

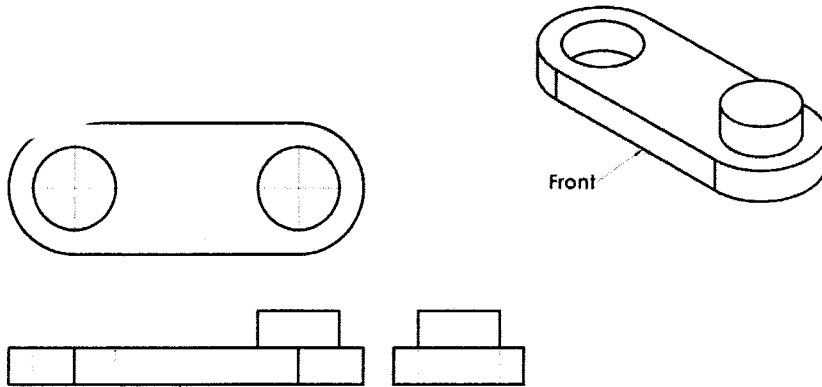
$$\therefore T_1 = 1.9242 \times T_2 \dots \dots \dots (ii)$$

Solving equation (i) and (ii),

$$T_2 = 1709.88 \text{ N and } T_1 = 3290.16 \text{ N}$$

$$\text{Power, } p = (T_1 - T_2) V = (3290.16 - 1709.88) \times 6.5 = 10.27 \text{ KW (Answer)}$$

12. Draw TOP VIEW, FRONT VIEW and RHS VIEW.



Bangladesh Power Development Board (BPDB)

Post: Assistant Engineer (Mechanical)

Date: 20.07.2018

Exam Hall: BUET

Total Marks-Non-departmental: $80 \times 0.5 = 40$; Departmental=60

[Non-Departmental= Math-5+ Computer-5+Bangla-10+ English-10 + GK- 10]

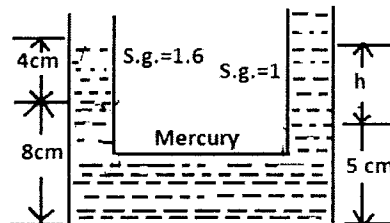
1. Find the value of h ?

Solution:

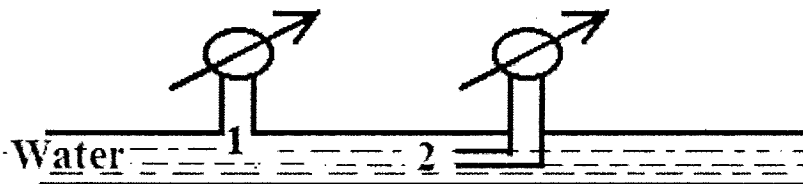
We get,

$$4 \times 1.6 + 8 \times 13.6 = h \times 1 + 5 \times 13.6$$

$$\Rightarrow h = 47.6 \text{ cm (Answer)}$$



2. A pipe has inner diameter 50mm and two gauge pressures are 100 KPa and 97KPa. If the viscous loss is 0.5 m of water, find the flow rate inside the pipe.



Solution: Given that, $P_1 = 100 \text{ KPa}$; $P_2 = 97 \text{ KPa}$; $H_L = 0.5 \text{ m of water}$

$$\text{We get, } \frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + H_L$$

$$\Rightarrow \frac{V_1^2}{2g} = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + H_L - \frac{P_1}{\gamma} - z_1$$

$$\Rightarrow \frac{V_1^2}{2g} = \frac{97 \times 10^3}{9.81 \times 10^3} + 0 + 0 + 0.5 - \frac{100 \times 10^3}{9.81 \times 10^3} - 0 = 0.1942$$

$$\Rightarrow V_1^2 = 3.81 \quad \therefore V_1 = 1.952 \text{ m/s}$$

$$\therefore Q = AV_1 = \frac{\pi}{4} \times D^2 \times V_1 = \frac{\pi}{4} \times 0.05^2 \times 1.952 = 3.83 \times 10^{-3} \text{ m}^3 \text{ (Answer)}$$

3. The bottom of a water containing tank shown below is of 2m wide rectangular sheet but into a quadrant link of radius 3m. Tank is 2m wide. Find resultant hydrostatic force on curve sheet.

Solution:

Horizontal force,

F_x = Total pressure force on OB

$$= \rho g A \bar{h}$$

$$= 1000 \times 9.81 \times 3 \times 2 \times \left(1 + \frac{3}{2}\right)$$

$$\therefore F_x = 147150 \text{ N}$$

[area of OB = OB × 2 = 3 × 2; \bar{h} = Depth of C.G. of CB

from free surface = $1 + \frac{3}{2}$]

Vertical force,

F_y = weight of water supported by AB upto free surface

= Weight of portion DABOC

= Weight of DAOC + Weight of water is AOB

= ρg [Volume of DAOC + Volume of water is AOB]

$$= 1000 \times 9.81 \left[(1 \times 3 \times 2) + \left(\frac{\pi}{4} \times 3^2 \times 2 \right) \right]$$

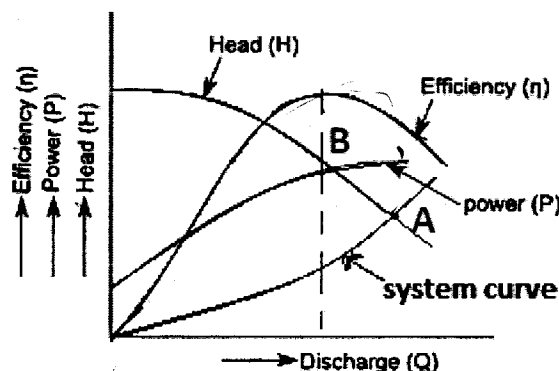
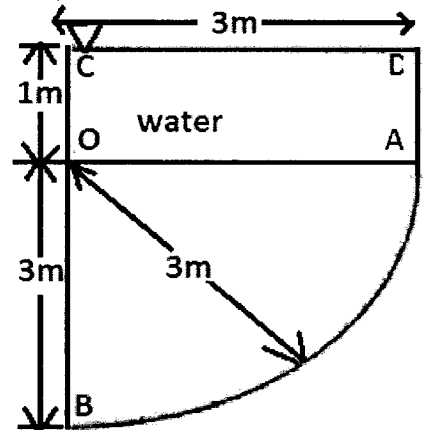
$$\therefore F_y = 197545.61 \text{ N}$$

$$\therefore \text{Resultant hydrostatic force} = \sqrt{147150^2 + 197545.61^2}$$

$$= 246327.8 \text{ N} = 246.33 \text{ kN (Answer)}$$

4. Draw the typical characteristic curve of centrifugal pump showing the design/duty point.

Answer: Here, Point A is the operating point (where system curve and head curve meets; system curve is a function of elevation or static head including major and minor losses). Point B is the **design** point (consider at best efficiency point).



5. Bsf of a diesel engine is 240g/KW hr. Calculate diesel consumption rate in litre/hr. Electric load is 30KW and alternator efficiency is 90%. (s.gr. 0.85)

Solution:

[Here, Electric load = alternator output; alternator input = Brake power]

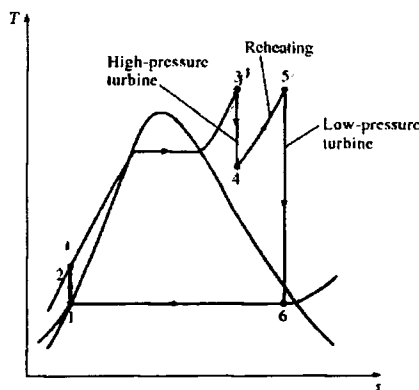
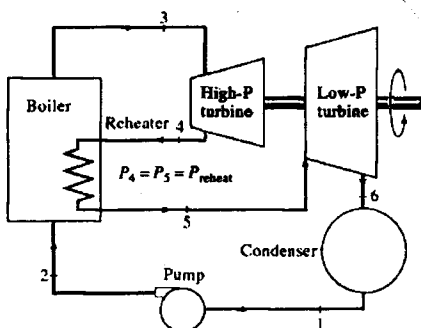
We get, alternator efficiency, $\eta_{al} = \frac{\text{Electrical load}}{\text{Brake power}}$; \Rightarrow Brake power = $\frac{30}{0.9} = 33.33\text{KW}$

Bsfc = $\frac{\dot{m}_f}{\text{brake power}}$; $\Rightarrow \dot{m}_f = 33.33 \times 240 \frac{\text{g} \times \text{KW}}{\text{KW hr}} = 8000 \frac{\text{g}}{\text{hr}} = 8\text{Kg/hr}$

$\therefore \dot{V}_f = \frac{8}{0.85 \times 1000} = 9.41 \times 10^{-3} \text{ m}^3/\text{hr} = 9.41 \text{ litre/hr (Answer)}$

6. Draw schematic diagram of reheat Rankine cycle and its T-S diagram and mention the efficiency with enthalpy of corresponding points.

Answer:



$$\text{Thermal Efficiency, } \eta = \frac{(h_3 - h_4) + (h_5 - h_6) - (h_2 - h_1)}{(h_3 - h_2) + (h_5 - h_4)}$$

$$[\text{Remember } \eta = \frac{\text{Turbine 1} + \text{Turbine 2} - \text{Pump}}{\text{Boiler} + \text{Reheat}}]$$

$$\text{or, Thermal Efficiency, } \eta = \frac{(h_3 - h_2) + (h_5 - h_4) - (h_6 - h_1)}{(h_3 - h_2) + (h_5 - h_4)}$$

$$[\text{Remember, } \eta = \frac{\text{Boiler} + \text{Reheat} - \text{condenser}}{\text{Boiler} + \text{Reheat}}]$$

Better to Know: Methods to increase the efficiency of the Rankine cycle

1. Lowering the condenser Pressure,
2. Superheating the steam to high temperatures and
3. Increasing the Boiler pressure

7. A 5 Ton refrigeration system consumes 3.75 kW find the COP and EER.

Solution: Given, Refrigeration Effect = 5TR = $5 \times 3.5 \text{ KW} = 17.5\text{KW} = 60000 \text{ BTU/hr}$
[1 Ton = 12000 BTU/hr]

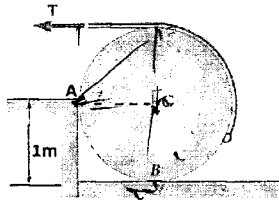
$$\text{We get, COP} = \frac{\text{Refrigeration Effect}}{\text{Power input}} = \frac{17.5}{3.75} = 4.67 \text{ (Answer)}$$

$$\text{EER} = \frac{\text{Refrigeration Effect (BTU/hr)}}{\text{Power input (W)}} = \frac{60000}{3.75 \times 1000} = 16 \text{ (Answer)}$$

Better to Know: EER = 3.412 × COP and EPR = COP + 1;

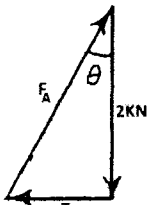
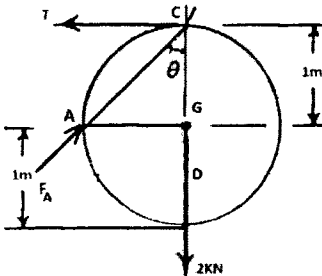
8. A 2KN cylindrical tank, 2m diameter, is to be raised over a 1m high obstruction. A cable is wrapped around the tank and pulled horizontally as shown. Knowing that

the corner of the obstruction at A is rough, find the required tension in the cable and the reaction at A.



Solution-01:

FBD:



$$R = F_A$$

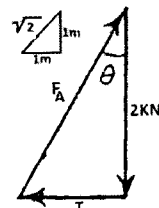
We get, $\tan \theta = \frac{1}{1} = 45^\circ$

From force triangle,

$$R = \frac{2}{\cos \theta} = \frac{2}{\cos 45^\circ} = 2.83 \text{ kN (Answer)}$$

$$T = 2 \tan \theta = 2 \tan 45^\circ = 2 \text{ kN (Answer)}$$

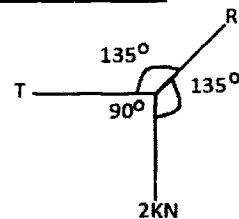
Solution-02:



$$\frac{2 \text{ kN}}{1} = \frac{R}{\sqrt{2}} = \frac{T}{1}$$

or, $R = 2 \times \sqrt{2} = 2.83 \text{ kN (Answer)}$
and, $T = 2 \text{ kN (Answer)}$

Solution-03:



$$\frac{T}{\sin 135^\circ} = \frac{R}{\sin 90^\circ} = \frac{2}{\sin 135^\circ}$$

$$R = \frac{2}{\sin 135^\circ} = 2.83 \text{ kN (Answer)}$$

$$T = 2 \text{ kN (Answer)}$$

9. The module of a mating spur gear set is 4mm. Pressure angle 25° , number of teeth on pinion 20 and gear ratio is 3, driver pinion runs at 1500 rpm and transmits 1000W to gear. Calculate: Driving force and separating force acting on gears.

Solution: Given, $m = 4 \text{ mm}$; $\theta = 25^\circ$; $T = 20$; gear ratio = 3; $N = 1500 \text{ rpm}$; $P = 1000 \text{ W}$

Driving Force, $F_t = ?$ and Separating Force, $F_n = ?$

We get, $m = \frac{D}{T}$

$$\text{Or, } D = m \times T = 0.004 \times 20 = 0.08 \text{ m}$$

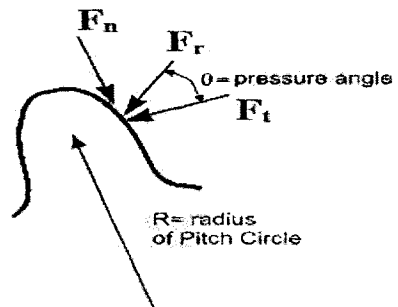
Now, $P = F_t V$

$$\text{Or, } F_t = \frac{P}{V} = \frac{P \times 60}{\pi D N} = \frac{1000 \times 60}{\pi \times 0.08 \times 1500} = 159.15 \text{ (Answer)}$$

Again, $F_n = F_t \tan \theta$

$$= 159.15 \times \tan 25^\circ$$

$$= 74.21 \text{ N (Answer)}$$



10. A thin walled steel boiler has a mean radius of 40mm and its thickness is 2mm, assuming the internal pressure is 25MPa, find out the (i) longitudinal stress, (ii) hoop stress and (iii) the maximum shear stress.

Solution: Given, $D = 80 \text{ mm}$; $t = 2 \text{ mm}$; $P = 25 \text{ MPa}$; $\sigma_t = ?$ $\sigma_l = ?$

Here, Longitudinal stress, $\sigma_L = \frac{PD}{4t}$

$$\sigma_l = \frac{25 \times 80}{4 \times 2} = 250 \text{ MPa (Answer)}$$

Tangential stress, $\sigma_t = \frac{PD}{2t}$

$$\sigma_t = \frac{25 \times 80}{2 \times 2} = 500 \text{ MPa (Answer)}$$

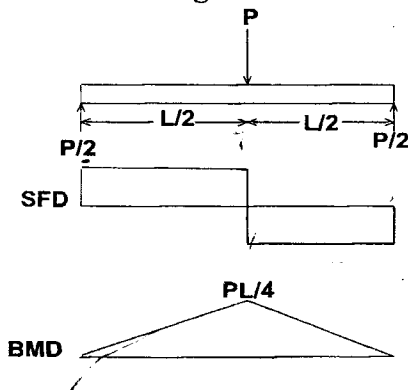
Maximum shear stress, $\tau_{\max} = \frac{\sigma_t - \sigma_l}{2} = \frac{500 - 250}{2} = 125 \text{ MPa (Answer)}$

Reference: A text of Machine Design-R.S.Khurmi, problem No. Example-7.2

Better to Know: Article 7.4 and 7.5 from above book focusing on the efficiency.

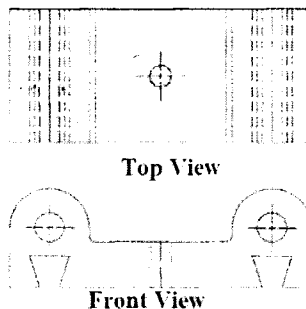
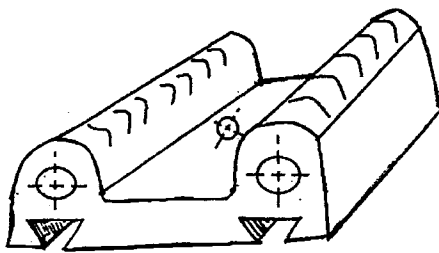
Maximum shear stress, $\tau_{\max} = \frac{PD}{8t}$

11. A concentrated load P is applied at the midspan of a simply supported beam of length L . Draw the bending moment and shear force diagram and identify the point that has highest tensile stress.

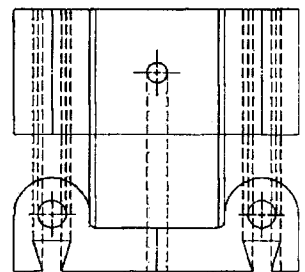


At the point at which load P acts, the bending moment at that point is maximum. At this point the beam will be most critically stressed.

12. Draw TOP VIEW and FRONT VIEW.



Explanation



Biman Bangladesh Airlines Ltd
Post: Assistant Engineer (Mechanical)

Date: 13.07.2018

Exam Time: 10:00 AM – 11:30 AM

Exam venue: MIST

Total Marks – 50(Non-Dept. MCQ)+50(Written Dept.) = 100

MCQ:

1. CAAB- founder 1985
2. ICAO - International Civil Aviation Organization
3. Caan festivals 2018 award- Plame d'Or winner : Shoplifters
4. 2018 FIFA world cup football name- Telstar 2018
5. Writer of “ The Old man & The sea” Ernest Hemingway
6. Present UN president is from which country : Portugal
7. Many computers are connected to a common computer : Star technology
8. USB : Universal Serial Bus
9. What kind of device is scanner : Input Device
10. Primary function of BIOS : Save OS
11. 2, 3, 5, 7 are : prime numbers
12. product of two consecutive number can be written as: n^2+n
13. $\sqrt[3]{5}$ can be also expressed as : $5^{\frac{1}{3}}$
14. $4^{x+1} = 32$, then find x ? $x = 3/2$

Departmental Question:

1. A 4 cylinder petrol engine has developed MEP=650 KPa, it's engine dia is 80 mm, stroke length is 100 mm, speed 3000 rpm. Find engine power in KW ?

Solution:

Since the stroke is not mention, so let us consider a four stroke engine.

We know,

$$\text{Indicated power, } P = \frac{PLANK}{60}$$

$$P = \frac{650 \times 0.1 \times 5.0265 \times 10^{-3} \times 1500 \times 4}{60}$$

$$P = 32.672 \text{ KW}$$

Given data:

K= no of cylinder=4

P=MEP=Mean Effective Pressure = 650 KPa

d=dia=80 mm = .08 m

$$A = \text{area} = \frac{\pi}{4} d^2 = \frac{\pi}{4} 0.08^2 = 5.0265 \times 10^{-3} \text{ m}^2$$

L = stroke length = 100 mm = 0.1 m

N= speed = 3000 rpm

n = N/2 , for four stroke engine = 3000/2 = 1500

P = engine power (KW) = ?

2. For counter flow heat exchanger $T_{h1}=160^{\circ}\text{C}$, $T_{h2}=125^{\circ}\text{C}$, $T_{c1}=20^{\circ}\text{C}$, $T_{c2}=80^{\circ}\text{C}$, Draw temperature distribution curve. Also Find arithmetic mean temperature difference & logarithmic mean temperature difference.

Answer:

We know,

AMTD = avg. hot temp. - avg. cold temp.

$$= \frac{T_{h1} + T_{h2}}{2} - \frac{T_{c1} + T_{c2}}{2} = \frac{160 + 125}{2} - \frac{20 + 80}{2} = 142.5 - 50 = 92.5^{\circ}\text{C}$$

Again for LMTD,

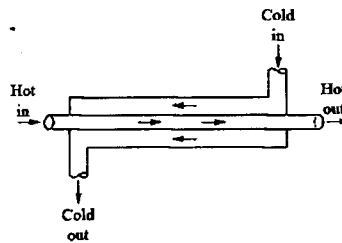
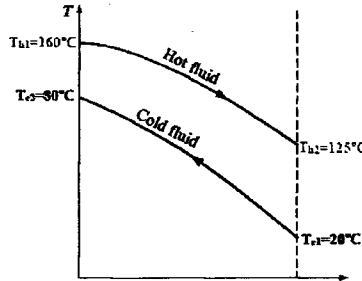
$$\Delta T_1 = T_{h1} - T_{c2} = 160 - 80 = 80$$

$$\Delta T_2 = T_{h2} - T_{c1} = 125 - 20 = 105$$

we know,

$$\begin{aligned} \text{LMTD} &= \frac{\Delta T_2 - \Delta T_1}{\ln \frac{\Delta T_2}{\Delta T_1}} = \frac{105 - 80}{\ln \frac{105}{80}} \\ &= \frac{25}{\ln \frac{105}{80}} = \frac{25}{0.2719} \\ &= 91.93^{\circ}\text{C} \end{aligned}$$

Counter flow temperature distribution:



Given data:

$$T_{h1} = 160^{\circ}\text{C}$$

$$T_{h2} = 125^{\circ}\text{C}$$

$$T_{c1} = 20^{\circ}\text{C}$$

$$T_{c2} = 80^{\circ}\text{C}$$

$$\text{AMTD} = ?$$

$$\text{LMTD} = ?$$

3. A wire has got dia of 20 mm, if heat transfer co efficient is $20 \text{ W/m}^2.\text{K}$ and thermal Conductivity is 0.5 W/m.k . then find the distance at which maximum heat dissipation will occur.

Answer: we know that at critical insulation of thickness maximum heat dissipation will occur.

distance = critical insulation of thickness = $\frac{k}{h}$

$$= \frac{0.5}{20} = 0.025 \text{ m} = 25 \text{ mm}$$

Given data:

$$h = \text{heat transfer co efficient} = 20 \text{ W/m}^2.\text{K}$$

$$K = \text{thermal Conductivity} = 0.5 \text{ W/m.k}$$

$$\text{distance} = ?$$

4. A $1.5\text{m} \times 1.5\text{m} \times 2\text{m}$ tank is kept at 11m above from the ground. If a pump installed on ground having efficiency of 60% can fill the tank in 30 min then, find the required pump power.

Answer: Flow rate, $Q = \frac{4.5\text{m}^3}{30 \times 60 \text{ sec}}$

$$= 2.5 \times 10^{-3} \text{ m}^3/\text{s}$$

we know, pump power, $P = \frac{\gamma H Q}{\eta}$

$$= \frac{9.81 \times 1000 \times 13 \times 2.5 \times 10^{-3}}{0.6} = 531.375 \text{ W}$$

Alternate solution:

$$\text{Pump power} = mgh/\eta t$$

$$= 4500 \times 9.81 \times 13 / 0.6 \times 30 \times 60 = 531.375 \text{ W}$$

Given Data:

$$v = \text{Volume of tank} = 1.5\text{m} \times 1.5\text{m} \times 2\text{m} =$$

$$4.5\text{m}^3 \text{ \& } m = \text{mass} = \rho v = 1000 \times 4.5 =$$

$$4500 \text{ Kg; elevation, } h = 11 + 2 = 13 \text{ m}$$

[taking that pump has to lift water from the ground to top of the tank]

$$\eta = \text{efficiency} = 60\% = 0.6$$

$$\text{time, } t = 30 \text{ min} = 30 \times 60 \text{ sec}$$

$$\text{Required pump power, } p = ?$$

5. Show that , specific speed of pump is a dimensionless number.

Solution:

$$\text{We know, } H = \frac{V^2}{2g} \Rightarrow H \propto V^2 \Rightarrow H = \frac{m^2}{s^2}$$

specific speed,

$$N_s = \frac{N\sqrt{Q}}{H^{3/4}}$$

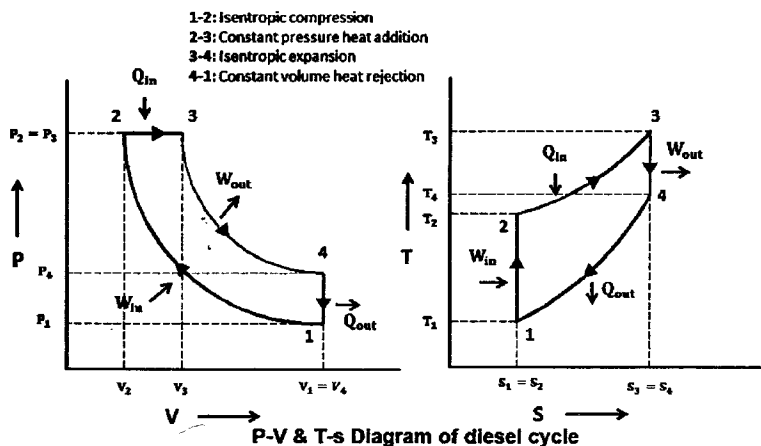
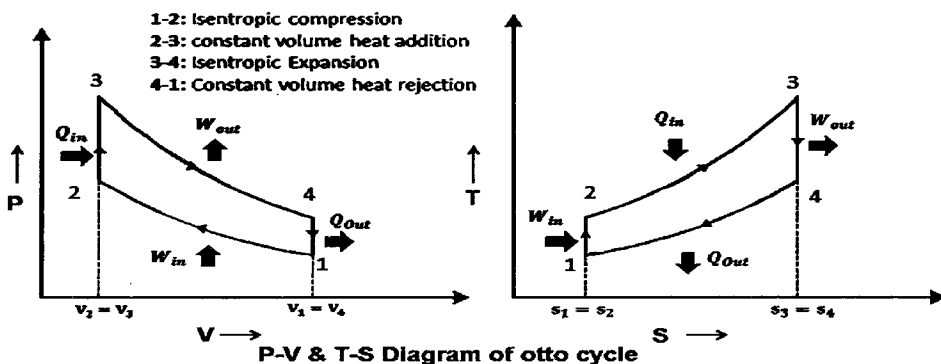
$$= \frac{\frac{1}{s} \times \sqrt{\left(\frac{m^3}{s}\right)}}{\left(\frac{m^2}{s^2}\right)^{3/4}}$$

$$= \frac{\frac{1}{s} \times \left(\frac{m^{3/2}}{s^{1/2}}\right)}{\left(\frac{m^{3/2}}{s^{3/2}}\right)}$$

$$= \frac{s^{3/2}}{s^{3/2}} = 1$$

Thus, specific speed of pump is dimensionless number.

6. Draw P-V & T-S diagram of otto & diesel cycle and write down the corresponding process name.



7. Find the absolute pressure in Pa of 100mm mercury vacuum pressure.

Answer:

$$\text{Abs. pressure} = \text{atm. pressure} - \text{vacuum pressue} = 760 - 100 = 660 \text{ mm of mercury}$$

$$P = hpg = 0.660 \times 13.6 \times 1000 \times 9.81 = 88054.56 \text{ Pa}$$

8. Engine power developed 40KW, solid shafts rpm 200 , if the shaft dia is 40 mm then find maximum torsional stress developer in the shaft.

Answer:

We know, power $P = T\omega = T \cdot 2\pi N/60$

$$T = 60P/2\pi N = 60 \times 40 \times 1000 / 2\pi \cdot 200 = 1909.85 \text{ Nm}$$

Again, Maximum stress, $\tau_{\max} = \frac{16T}{\pi d^3}$

$$= \frac{16 \times 1909.85}{\pi (0.04)^3} = 151.98 \text{ MPa}$$

9. Find the deflection of a solid circular steel bar having load 500 kg, length 2.5 m, dia 60mm & E=200 GPa

Answer:

We know, deflection, $\delta = \frac{PL}{AE}$

$$= \frac{4905 \times 2.5}{2.82 \times 10^{-3} \times 200 \times 10^9} = 0.0217 \text{ mm}$$

Given data:

P = power = 40 KW

N = speed = 200 rpm

d = dia = 40 mm = 0.04 m

$\tau_{\max} = ?$

Given data:

P = load = $500 \times 9.81 \text{ N} = 4905 \text{ N}$

L = length = 2.5 m

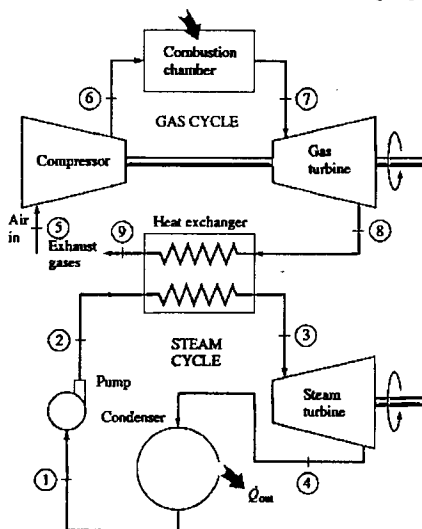
d = 60 mm = 0.06 m

A = cross sectional area = $\frac{\pi d^2}{4} = \frac{\pi (0.06)^2}{4}$

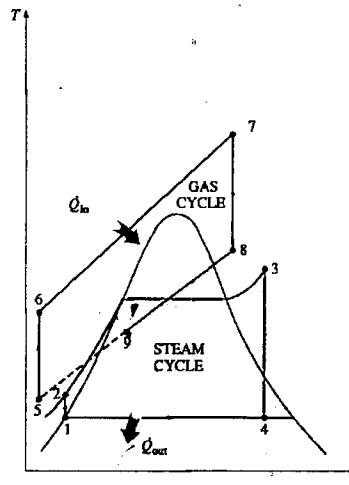
$$= 2.82 \times 10^{-3} \text{ m}^2$$

E = 200 Gpa = $200 \times 10^9 \text{ Pa}$

10. Draw block diagram & T-S diagram for gas-steam combine cycle power plant.



Combined gas-steam power plant.



11. A 60 mm metal ball at 220°C is being cooled by air jet of 20°C, heat transfer coefficient 200 W/m.k & 100 W/m².K, if the specific heat of the metal ball 400 J/Kg.K, density 9000Kg/m³, find the temperature of the ball after 90 sec.

Solution:**We know,**

$$\frac{T_{90s} - T_a}{T_i - T_a} = e^{-\left(\frac{hA}{\rho CV}\right)t}$$

$$\frac{T_{90s} - 20}{220 - 20} = e^{-\left(\frac{100 \times 4\pi r^2}{9000 \times 400 \times \frac{4}{3} \times \pi r^2}\right)t}$$

$$\Rightarrow \frac{T_{90s} - 20}{200} = e^{-\left(\frac{100 \times 3}{9000 \times 400 \times 0.03}\right) \times 90}$$

$$\Rightarrow \frac{T_{90s} - 20}{200} = e^{-0.25}$$

$$\therefore T_{90s} = 200 \times 0.7788 + 20 = 155.76 + 20 \\ = 175.76^\circ\text{C}$$

Given Data:

$$d = 60 \text{ mm} = .06 \text{ m}$$

$$r = d/2 = .03 \text{ m}$$

$$A = \text{surface area of metal ball} = 4\pi r^2$$

$$V = \text{volume of metal ball} = \frac{4}{3}\pi r^3$$

$$T_i = \text{initial temp.} = 220^\circ\text{C}$$

$$T_a = 20^\circ\text{C}$$

$$K = 200 \text{ W/m.K}$$

$$h = 100 \text{ W/m}^2.\text{K}$$

$$C = 400 \text{ J/Kg.K}$$

$$\rho = 9000 \text{ Kg/m}^3$$

$$t = 90 \text{ sec}$$

$$\text{temp. after 90 sec, } T_{90s} = ?$$

12. An aeroplane makes a complete half circle of 50 metres radius, towards left, when flying at 200 km per hr. The rotary engine and the propeller of the plane has a mass of 400 kg and a radius of gyration of 0.3 m. The engine rotates at 2400 r.p.m. clockwise when viewed from the rear. Find the gyroscopic couple on the aircraft.

Answer:

$$\text{we know, } \omega = 2\pi N/60 = 2\pi \times 2400/60 \\ = 251 \text{ rad/s}$$

Moment of inertia,

$$I = mK^2 = 400 \times 0.3^2 = 36 \text{ Kg-m}^2$$

Angular velocity of precession,

$$\omega_p = V/R = 55.556 / 50 = 1.11 \text{ rad/sec}$$

Gyroscopic couple, $C = I.\omega.\omega_p$

$$= 36 \times 251 \times 1.11 = 10.046 \text{ KN-m}$$

Given Data:

$$R = 50 \text{ m}$$

$$V = 200 \text{ Km/hr} = 55.556 \text{ m/s}$$

$$m = 400 \text{ Kg}$$

$$K = 0.3 \text{ m}$$

$$N = 2400 \text{ rpm}$$

$$\text{gyroscopic couple, } C = ?$$

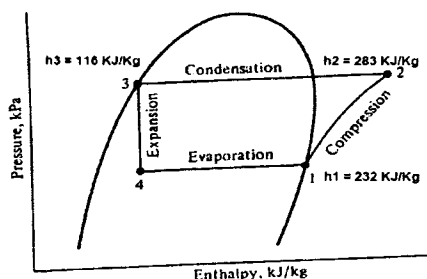
13. In a vapor compression refrigeration cycle inlet condenser enthalpy is 283 KJ/Kg, exit condenser enthalpy is 116 KJ/Kg, exit evaporator enthalpy is 232 KJ/Kg, Find COP.

Answer:**We have,**

$$\text{COP} = \frac{\text{Cooling effect}}{\text{compressor work}}$$

$$= \frac{h_1 - h_4}{h_2 - h_1} = \frac{232 - 116}{283 - 232}$$

$$= \frac{116}{51} \\ = 2.2745$$

Given :

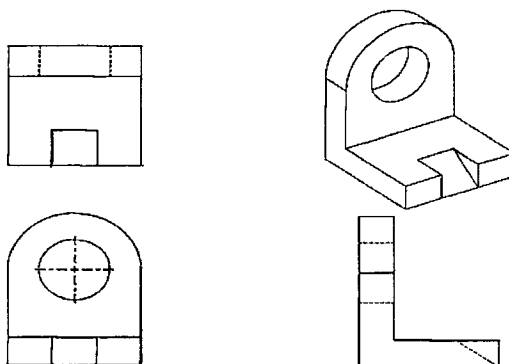
According to the P-h figures,

$$h_2 = \text{enthalpy at inlet of condenser} = 283 \text{ KJ/Kg}$$

$$h_3 = h_4 = \text{enthalpy at exit of condenser} = 116 \text{ KJ/Kg}$$

$$h_1 = \text{enthalpy at the inlet of compressor} = 232 \text{ KJ/Kg}$$

14. Draw all necessary orthographic views of the following objects.



Bangladesh Rural Electrification Board
Post: Assistant Engineer (Mechanical)

Date: 08.06.2018

Exam Time: 10:00 AM – 11:30 AM

Exam venue: MIST

Total Marks – 60(Non-Dept. MCQ) +40(Written Dept.) = 100

1. What's type of reactor will use in rooppur nuclear power plant? **VVER-1200/523**, VVER-1200/521, VVER-1000/523, VVER-1000/521
2. Types of transponder of bangabandhu satellite-1? 26(ku-band) & 14(c-band), 24(ku-band) & 16(c-band), 16(ku-band) & 24(c-band), 14(ku-band) & 26(c-band)
3. If length of a wire is 0.1% increased, resistance will be increased by? 0.2%, 0.3%, 0.4%, 0.5%
4. If distance between sun and earth decreased by half, how many days will make a year?
 130, 139, 125, **129**

Solution:

We know,

Kepler third law, $T^2 = R^3$

$$\therefore \frac{T_2}{T_1} = \frac{R_2^{\frac{3}{2}}}{R_1^{\frac{3}{2}}} \text{ or, } \frac{T_2}{T_1} = \left(\frac{R_2}{R_1}\right)^{\frac{3}{2}}; T_2 = \frac{T_1}{2\sqrt{2}} = \frac{365}{2\sqrt{2}} = \mathbf{129 \text{ days}}$$

Given Data

$$T_1 = 365 \text{ days}$$

$$R_1 = R$$

$$T_2 = ?$$

$$R_2 = R/2$$

5. Aspect ratio of a TV screen is 16:9 (width: height), if perimeter of screen is 100, calculate width of screen?

Solution: $2(16x+9x) = 100$ Or, $x = 2$ \therefore Width = $9x = 9 \times 2 = \mathbf{18}$

6. If 5 tickets are sold in price of 3 tickets, what's the amount saved while buying them?
 33.33%, **66.66%**-----

7. If regular price of a book is of 20% discount of its original price and on an occasion 15% discount is given on regular price, what's the actual discount? 20%, 30%, 32%, 38%

If original price is 100 tk then,

$$100(1-0.2) \times (1-0.15) = 68 \text{ tk, discount} = 100 - 68 = \mathbf{32 \%}$$

8. Google's actual company name is- **Google Inc**, Google Corporation, -----, -----

9. An object of 1000 kg entered earth, earth radius 6400 km, gravity 9.81, with what velocity the object will hit earth? **11.2 Km/s**, 12.2 km/s, 12 km/s, 11 km/s

10. A rectangle's length is thrice its width & perimeter is 36 m then find the width?

9 m, **4.5 m**, 10 m, 18 m

$2(x+3x)=36$ or $x=4.5$ m, width = **4.5 m**

11. There were 8 girls, 20 boys on Thursday Next day girls joined twice the boys left, now girl: boy ratio is 4:1, how many boys left Thursday? 12, 6, 11, 9

12. নিচের কোনটিতে অসমান কর্তা আছে? তোমরা বাড়ি এলে আমি রওনা দিব।

13. আমার ভিতর বাহিরে অন্তরে অন্তরে আছো তুমি হৃদয় জুড়ে এই গানের রচয়িতা কে? **Rudra Mohammad Shahidullah**

14. The longest sea bridge of world connected three countries: **Hong Kong-Zhuhai-Macau**

15. The opposition if word "Suffrage"?

16. "PLAY WITH AN OPEN HEART" a slogan from which country in world cup FIFA 2018?

17. সঠিক সন্ধি বিচ্ছেদ কোনটি? কিম+ভুত = কিম্ভুত

31. Calculate P^H value for 2% NaOH solution.

Answer:

We know,

$$\text{Concentration, } S=[OH]=\frac{1000W}{MV}=\frac{1000 \times 2}{40 \times 100}=0.5 \text{ M}$$

$$\text{again, } P^{OH} = -\log [OH] = -\log [0.5] = 0.301$$

$$\text{We have, } P^H + P^{OH} = 14$$

$$P^H = 14 - P^{OH} = 14 - 0.301 = 13.699$$

32. a) Determine the area enclosed by $y=x^2$, x axis, $x=1$, $x=3$ lines

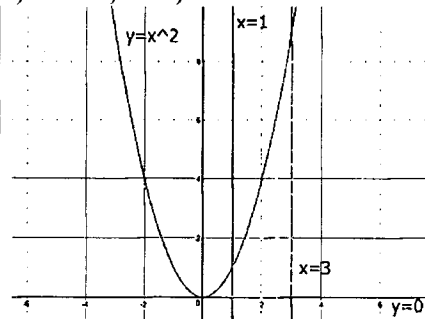
Answer:

From figure, let $f(x) = y = x^2$ & $g(x) = y=0$

limiting functions, $x=1$, $x=3$

By integration,

$$\begin{aligned} \text{Area} &= \int_{x=1}^{x=3} \{f(x) - g(x)\} dx \\ &= \int_{x=1}^{x=3} \{x^2 - 0\} dx = \int_{x=1}^{x=3} x^2 dx \\ &= \left[\frac{x^3}{3} \right]_1^3 = \left[\frac{3^3}{3} \right] - \left[\frac{1^3}{3} \right] = \frac{27}{3} - \frac{1}{3} = \frac{26}{3} \end{aligned}$$



b) A car running at 72km/h and taking U turn in 4 sec. what is the acceleration of the car?

Answer:

Acceleration
taking U-turn,

$$\begin{aligned} a &= v^2/r \\ &= 20^2/25.464 \\ &= 15.07 \text{ m/s}^2 \end{aligned}$$

while

Given Data

$$V = 72 \text{ Km/hr} = 20 \text{ m/s}$$

$$t = 4 \text{ sec}$$

$$\begin{aligned} \text{distance travelled, } s &= vt = 20 \times 4 \\ &= 80 \text{ m} \end{aligned}$$

$$\text{again, } s = r \pi$$

$$\text{hence, } r = s/\pi = 80/\pi = 25.464 \text{ m}$$



33. a) Steel pipe of 120mm dia rests horizontally having temp of 25 degree Celsius, $K=0.05 \text{ W/m.k}$, nusselt number =30, calculate heat transfer coefficient.

Answer:

We know,

Nusselt number,

$$Nu = h L_c / K$$

$$h = Nu.K / L_c$$

$$= 30 \times 0.05 / 0.12$$

$$12.5 \text{ W/m}^2 \cdot \text{K}$$

Given Data

$L_c = \text{Characteristic length} = \text{hydraulic dia for pipe} = 4A/P$

$$= 4 \times (\pi D^2/4) / \pi D = D = 120 \text{ mm} = 0.12 \text{ m}$$

$$T = 25 + 273 = 298 \text{ K}$$

$$K = 0.05 \text{ W/m.k}$$

$$Nu = 30$$

$$h = ?$$

b) Sum of two numbers is 20, if cube of one number multiplied by other is a maximum, calculate the two numbers.

Answer:

$$x + y = 20 \text{ ---- (1) and } x^3 y \text{ is maximum}$$

Now take the value of y from equation (1).

$$= x^3 (20 - x) = 20x^3 - x^4$$

Now differentiate in terms of x and putting it equal to 0 which is the slope of the graph at the maxima or minima

$$0 = 60x^2 - 4x^3, \text{ which gives } x = 0 \text{ or } 15$$

As if $x = 0$ here comes minima thus $x = 15$ which makes the numbers as **15 & 5**

34. a) A gas with 27 degree Celsius temperature, atmospheric pressure, suddenly compressed to half of its original volume, calculate final temperature and pressure.

Answer:

Sudden compression = isentropic process

$$T_2 / T_1 = (V_1 / V_2)^{(\gamma-1)}$$

$$T_2 = T_1 \times (V_1 / V_2)^{(\gamma-1)}$$

$$= 300 \times (V / 0.5V)^{(1.4-1)}$$

$$= 300 \times (2)^{0.4} = 395.85 \text{ K}$$

Again,

$$P_2 / P_1 = (V_1 / V_2)^\gamma$$

$$P_2 = P_1 \times (V_1 / V_2)^\gamma$$

$$= 101325 \times (V / 0.5V)^{1.4}$$

$$= 101325 \times (2)^{1.4}$$

$$= 267398.3 \text{ Pa}$$

Given Data

$$T_1 = 27 + 273 = 300 \text{ K}$$

$$P_1 = 101325 \text{ Pa}$$

$$V_1 = V \text{ (let)}$$

$$V_2 = 0.5V$$

$$T_2 = ?, P_2 = ?$$

$$\gamma = 1.4$$

b) Single point cutting tools having Taylor Exponent 0.25, if cutting speed is halved, what will be the tool life?

Answer: We have,

Taylor's equation for tool life expectancy ,

$$VT^n = C$$

$$\therefore V_1 T_1^n = V_2 T_2^n$$

$$\text{or } T_2 = T_1 \times (V_1 / V_2)^{(1/n)} = T \times (V / 0.5V)^{(1/0.25)}$$

$$= T \times (2)^{(1/0.25)} = 16T$$

So, cutting speed is halved then tool life will be increased by

16th times

Given Data

$$n = \text{Taylor exponent} = 0.25$$

$$V_1 = \text{cutting speed} = V \text{ (let)}$$

$$T_1 = \text{tool life} = T \text{ (let)}$$

$$V_2 = 0.5V$$

$$T_2 = ?$$

35.a) A pump having head of 50 m, flow rate 60 liter/sec. if the suction line is 100 m long & diameter 100 mm, pump has overall efficiency of 70%, the find power required to drive the pump. $f=0.003$

Answer:

we know, power,

$$P = \frac{\gamma H Q}{\eta}$$

$$P = \frac{9.81 \times 1000 \times 50.40475 \times 0.06}{0.7}$$

$$= 42.383 \text{ KW}$$

we know, $Q = AV$

$$V = Q/A = Q/(\pi D^2/4)$$

$$= 0.06/[\pi(0.1)^2/4] = 0.764 \text{ m/s}$$

$$\text{Total head} = H + H_d + H_f$$

$$= H + \frac{v^2}{2g} + \frac{4f l v^2}{2g d}$$

$$= 50 + \frac{(0.764)^2}{2 \times 9.81} + \frac{4 \times 0.003 \times 100 \times (0.764)^2}{2 \times 9.81 \times 0.1}$$

$$= 50 + 0.2975 + 0.375 = 50.40475 \text{ m}$$

Given Data

$$H = 50 \text{ m}$$

$$Q = 60 \text{ liter/sec} = 0.06 \text{ m}^3/\text{s}$$

$$l = 100 \text{ m}$$

$$d = 100 \text{ mm} = 0.1 \text{ m}$$

$$\eta_{\text{pump}} = 70\% = 0.7$$

$$f = 0.003$$

$$\text{Power, } P = ?$$

b) Automobile engine has weight of 240 Kg, rested on four springs, front spring has spring constant of 16 MN/m, other springs having 32 MN/m. Find frequency at which resonance will occur.

Answer:

We know, frequency at which resonance will occur,

$$f = \frac{1}{2\pi} \sqrt{\frac{K}{m}} = \frac{1}{2\pi} \sqrt{\frac{96 \times 10^6}{240}}$$

$$= 100.618 \text{ Hz}$$

Given Data

$$m = 240 \text{ Kg}$$

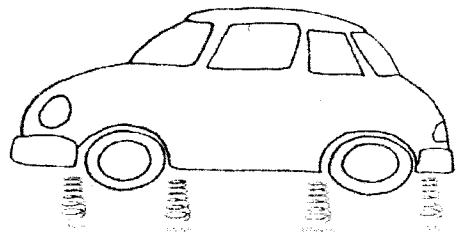
$K = \text{Equivalent spring constant}$

$$= K_{f1} + K_{f2} + K_{b1} + K_{b2}$$

$$= 16 + 16 + 32 + 32$$

$$= 96 \text{ MN/m}$$

$$f = ?$$



All springs are in parallel

36.a) A tyre is designated 145/70 R 12 69 S. What do you understand by "145/70 R"?

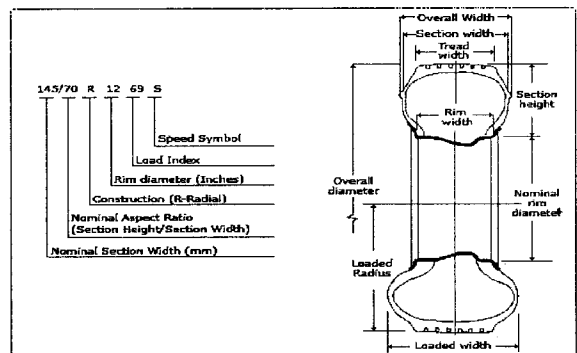
Answer:

145/70 R means,

The section width or thickness of tyre from shoulder to shoulder is **145 mm**.

The aspect ratio is **70%**, aspect ratio is defined as the ratio of section height to section width of the tyre. In this case it means section height is **70%** of section width i.e., 101.5 mm.

R represents that the tyre is radial.



b) A hydroelectric turbine having head of 24.5 m, flow rate $10 \text{ m}^3/\text{s}$, efficiency 90% and speed 4 rps, which type of turbine to be used.

Ans:

We know, turbine power

$$P_{\text{turbine}} = \gamma H Q \eta = 9.81 \times 1000 \times 24.5 \times 10 \times 0.9 = 2163.105 \text{ KW}$$

Again turbine specific speed,

$$N_s = \frac{N \sqrt{P}}{(H)^{(5/4)}} = \frac{240 \sqrt{2163.105}}{(24.5)^{(5/4)}} = 204.78$$

As specific speed is between 50~ 250 so Francis turbines should be used.

Given Data

$$H = 24.5 \text{ m}$$

$$Q = 10 \text{ m}^3/\text{s}$$

$$\eta = 90\% = 0.9$$

$$N = 4 \times 60 \text{ rpm} = 240 \text{ rpm}$$

$$\text{Types of turbine} = ?$$

37 (a) Solid circular shaft having diameter 60 mm & torque 2000 Nm. Find maximum shearing stress in that shaft ?

Ans:

We know,

$$\tau_{\max} = \frac{16T}{\pi D^3} = \frac{16 \times 2000}{\pi \times (0.06)^3}$$

$$= 47.156 \text{ Mpa}$$

Given Data

$$D = 60 \text{ mm} = 0.06 \text{ m}$$

$$T = 2000 \text{ N-m}$$

$$\tau_{\max} = ?$$

North West Power Generation Company Limited (NWPGL)

Post: Assistant Engineer(Mechanical)

Time 10.00AM to 11.30AM

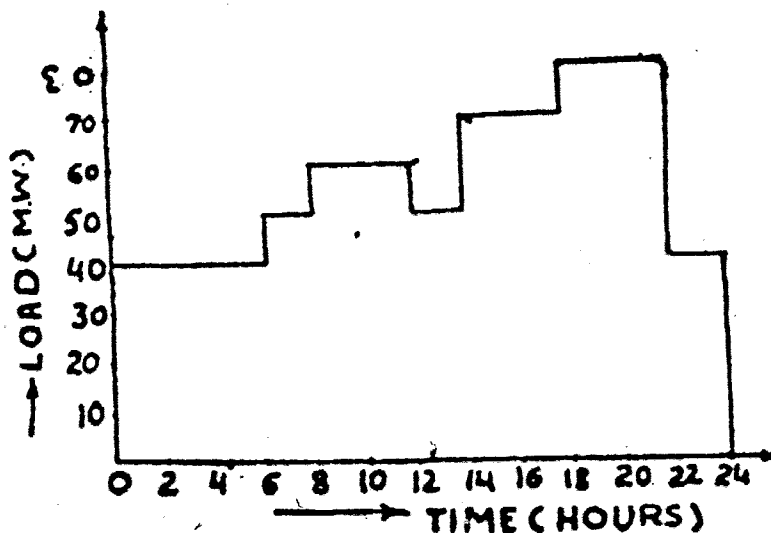
Date:22.09.2018

Exam Hall: ECE Building, BUET

1. A power station has to supply load as follows:

Time (Hours)	0-6	6-12	12-14	14-18	18-24
Load (MW)	30	90	60	100	50

Solution:



$$\text{Average Load} = \frac{(30 \times 6) + (90 \times 6) + (100 \times 4) + (50 \times 6)}{24} = 64.16 \text{ KW}$$

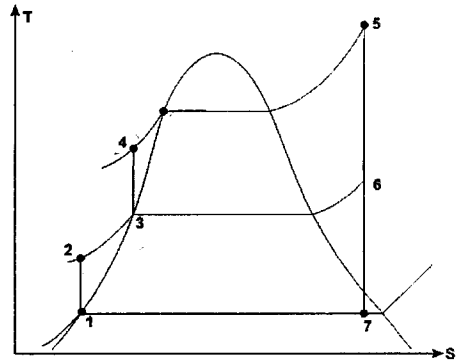
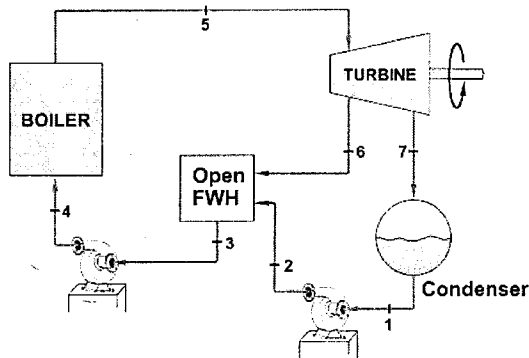
$$\text{Maximum Demand} = (100 \times 1000) \text{ KW}$$

$$\therefore \text{Load factor} = \frac{64160}{100000} = 0.6416 = 64.16\% \text{ (Answer)}$$

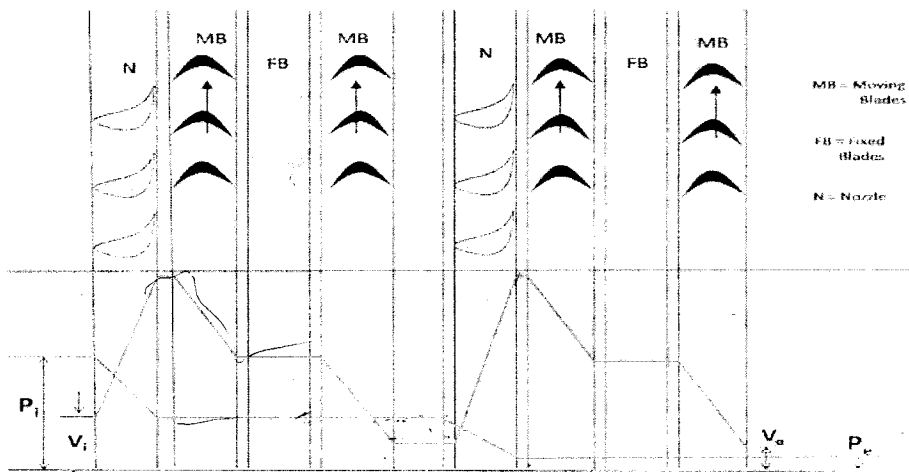
2. Write the name of the below power plant and draw corresponding T-S diagram.

Solution:

The below power plant is Rankine cycle with open feed water heater.



3. Draw the pressure-velocity lines for the diagram below.



4. On a sunny day, the internal and external temperatures of a room was 20°C and 5°C respectively. The glass thickness of the room is 8mm and thermal conductivity was 0.8 W/mK . The internal and external heat transfer coefficient is $15\text{ W/m}^2\text{K}$ respectively. Find the overall heat transfer rate per unit area.

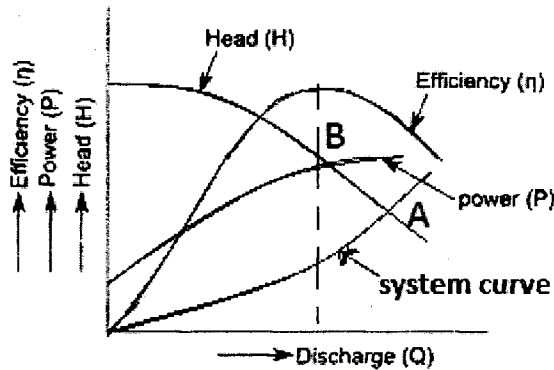
Solution:

$$\frac{Q}{A} = \frac{t_1 - t_2}{\frac{1}{h_i} + \frac{x}{k} + \frac{1}{h_o}} = \frac{20 - 5}{\frac{1}{15} + \frac{0.008}{0.8} + \frac{1}{5}} = 54.22\text{ W/m}^2$$

5. Draw the performance curve of centrifugal pump with the system curve, showing the design and operating point.

Answer:

Here, Point A is the operating point (where system curve and head curve meets; system curve is a function of elevation or static head including major and minor losses.). Point B is the design point (consider at best efficiency point).



6. Refrigerant R-134a enters the capillary tube of a refrigerator as saturated liquid at 0.8MPa ($T_{\text{sat}} = 31.31^\circ\text{C}$, $h_1 = 95.48 \text{ KJ/Kg}$, $h_{g1} = 245.64 \text{ KJ/Kg}$) and is throttled to a pressure of 0.12MPa ($T_{\text{sat}} = 22.32^\circ\text{C}$, $h_f = 22.47 \text{ KJ/Kg}$, $h_{g2} = 236.99 \text{ KJ/Kg}$). Determine the quality of the refrigeration.

Solution: Quality, $x = \frac{h_1 - h_f}{h_{g2} - h_f} = \frac{95.48 - 22.47}{236.99 - 22.47} = 0.340$ (Answer.)

Explanation: $h_1 = h_f + xh_{fg}$; $x = \frac{h_1 - h_f}{h_{fg}} = \frac{h_1 - h_f}{h_{g2} - h_f}$

7. A bar of length 3m and area 320 mm^2 is supported between two rigid bodies. The bar is stress free at 5°C . Find the temperature at which the compressive stress will be 36MPa. Using $E=80\text{GPa}$ and $\alpha = 18 \times 10^{-6} \text{ m/m}^\circ\text{C}$.

Solution: We get,

$$\sigma = \alpha E \Delta T$$

$$\Rightarrow 36 \times 10^6 = 80 \times 10^9 \times 18 \times 10^{-6} \times \Delta T$$

$$\Rightarrow \Delta T = \frac{36 \times 10^6}{80 \times 10^3 \times 18} = 25$$

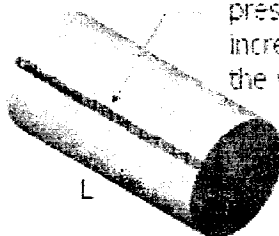
$$\Rightarrow T_2 - T_1 = 25$$

$$\Rightarrow T_2 = 25 + 5 = 30^\circ\text{C} \text{ (Answer)}$$

8. A cylindrical steel pressure vessel 400mm in diameter with a wall thickness of 20mm, is subjected to an internal pressure of 4.5 MN/m^2 . To what value may the internal pressure be increased if the stress in the steel is limited to 120 MN/m^2 . If the internal pressure were increased until the vessel burst, sketch the type of fracture that would occur.

Solution: We get, $\sigma = \frac{PD}{2t} \Rightarrow P = \frac{\sigma \times 2t}{D} = \frac{120 \times 2 \times 20}{400} = 12 \text{ MPa}$ (Answer)

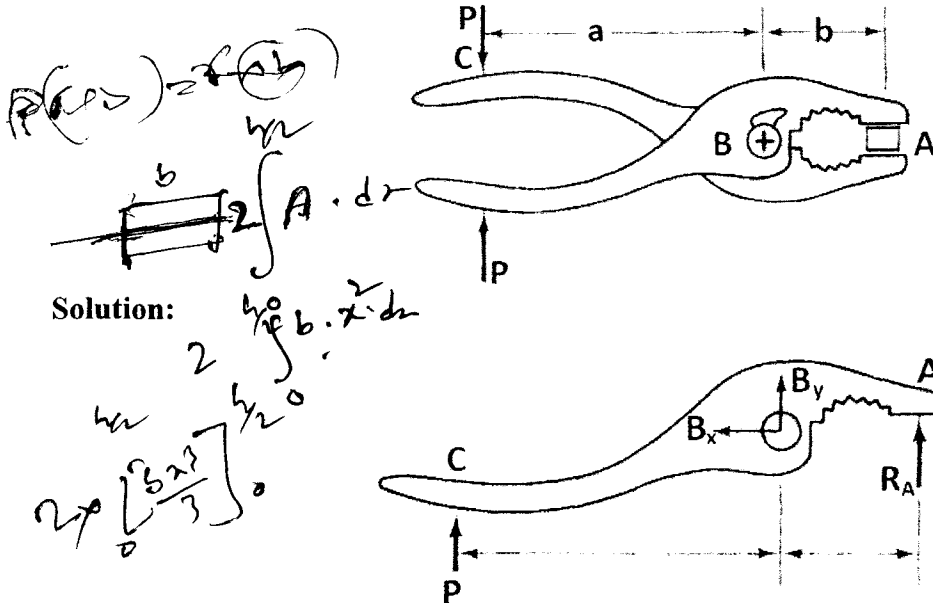
Expected fracture when internal pressure is increased until the vessel burst



9. Find the tensile stress and the point where it has maximum bending.

Solution: Flexural Stress, $\sigma = \frac{M}{S} = \frac{PL}{\frac{bh^3}{6}} = \frac{6PL}{bh^3}$ (Answer)

10. If force P is applied at point C to cut a wire at point A, What will be the shear force at rivet of point B?



Solution:

$$\sum M_B = 0$$

$$\Rightarrow P \times a - R_A \times b = 0$$

$$\Rightarrow R_A = \frac{Pa}{b}$$

$$\therefore B_y = P \left(\frac{a+b}{b} \right) \downarrow \text{ (Answer)}$$

$$\therefore \sum F_y = 0$$

$$\Rightarrow R_A + P + B_y = 0$$

$$\Rightarrow B_y = -\frac{Pa}{b} - P = -P \left(\frac{a+b}{b} \right)$$

11. A motorcyclist is running with a speed of 30m/s. Suddenly he applied brake, the motorbike stopped after 75m skidding. Determine the co-efficient of friction between tyres and road.

Solution:

$$V^2 = U^2 - 2as$$

$$\Rightarrow 0 = (30)^2 - 2 \times a \times 75$$

$$\Rightarrow a = 6 \text{ m/s}^2$$

$$\text{Again, } F = ma = \mu N$$

$$\text{Here, } N = mg$$

$$\therefore ma = \mu mg$$

$$\Rightarrow \mu = \frac{a}{g} = \frac{6}{9.81} = 0.612 \text{ (Answer)}$$

12. Drawing.

Non-Departmental

1. বঙ্গ বন্ধুর ৭ই মার্চ এর ভাষণ সর্বপ্রথম কোন চলচিত্রে ব্যবহার করা হয়?

উত্তর: ওরা ১১ জন

2. 'নিশীত' রাতে বাজেছে বাঁশি' বাক্যে 'নিশীত' শব্দটি কোন পদ--

ক. বিশেষ্য খ. বিশেষণ গ. সর্বনাম ঘ. অব্যয়

উত্তর: খ

3. আগুনের সমার্থক শব্দ কি?
4. Robot Sophia is developed by the company- **Hanson Robotics**
5. Who is the current prime minister of Australia?- **Hon Scott Morrison**
6. What is the percentage of power produced by government?
7. Which one is the most common type of motor is used?
 - a. two phase squireel case induction
 - b. two phase induction
 - c. three phase induction
 - d. three phase synchronous

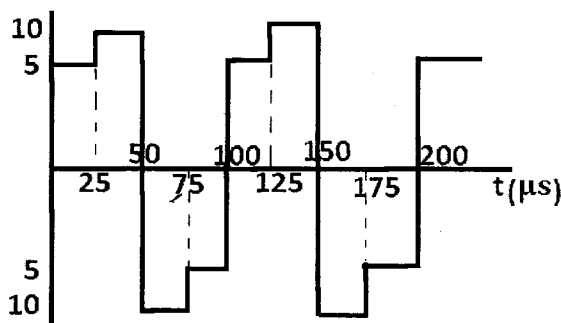
Answer: a

8. Rooppur Nuclear power plant will go into operation at- **2023**.
 9. Barapukuria Coal Power Plant is located at- **Dinajpur**
 10. Antonym of - **equivocal, impediment**
 11. Synonym of- **amicable**
 12. In Bangladesh which one is called as “white gold”- **Lobster**
- More analytical & GK questions.

Bangladesh Water Development Board (BWDB)**Post: Assistant Engineer(Mechanical/Electrical)****Time-10.00AM to 11.30AM****Date:03.02.2017****Exam Hall: ECE Building, BUET**

এই পরীক্ষায় মেকানিক্যাল এবং ইলেক্ট্রিক্যালের কন্সাইন্ড প্রশ্ন হয়েছিল। তবে প্রশ্নের দুইটা আলাদা সেট ছিল। দুই সেটে প্রশ্ন প্রায় একই ছিল শুধু কিছু ডাটা পরিবর্তন ছিল।

1. The following ac voltage is applied to the terminals of a 6 ohm resistor. What is the average power dissipated in the resistor?

 $V_x(V)$ **Solution:**

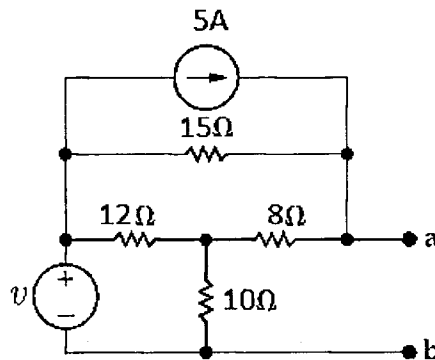
$$\begin{aligned}
 V_{rms}^2 &= \left[\frac{1}{100} \int_0^{25} 5^2 dt + \int_{25}^{50} 10^2 dt + \int_{50}^{75} (-10)^2 dt + \int_{75}^{100} (-5)^2 dt \right] \\
 &= \frac{1}{100} \left[25 \int_0^{25} dt + 100 \int_{25}^{50} dt + 100 \int_{50}^{75} dt + 25 \int_{75}^{100} dt \right]
 \end{aligned}$$

$$\begin{aligned}
 &= \frac{1}{100} [25 \times (25 - 0) + 100(50 - 25) + 100 \times (75 - 50) + 25 \times (100 - 75) \\
 &= \frac{1}{100} [25 \times 25 + 100 \times 25 + 100 \times 25 + 25 \times 25] \\
 &= 62.5
 \end{aligned}$$

$$\therefore V_{\text{rms}} = \sqrt{62.5} = 7.90\text{V}$$

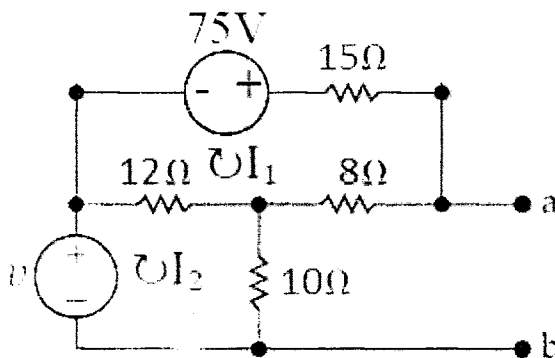
$$\text{Average Power} = \frac{V_{\text{rms}}^2}{R} = \frac{7.90^2}{6} = 10.4\text{W (Answer)}$$

2. Find the Thevenin equivalent circuit with respect to terminals a,b for the following circuit.

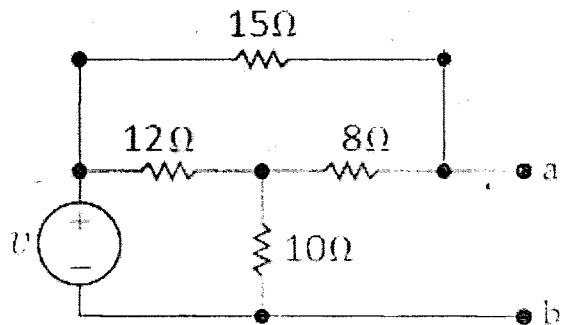


Solution:

Thevenin Equivalent Voltage V_{th} :



Thevenin Equivalent resistance R_{th} :



$$R_{\text{th}} = (10 \parallel 12 + 8) \parallel 15 = 7.09\Omega$$

We get for 1st Mesh:

$$i_1 \times (15 + 8 + 12) - 12i_2 = 75 \\ \Rightarrow 35i_1 - 12i_2 = 75 \dots \dots \dots (i)$$

For 2nd Mesh:

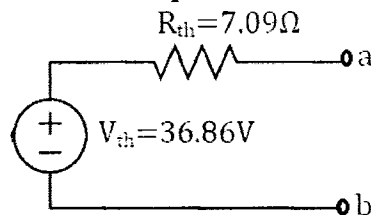
$$i_2 \times (12 + 10) - 12i_1 = 2 \\ \Rightarrow 22i_2 - 12i_1 = 2 \dots \dots \dots (ii)$$

Solving equation (i) and (ii) we get,

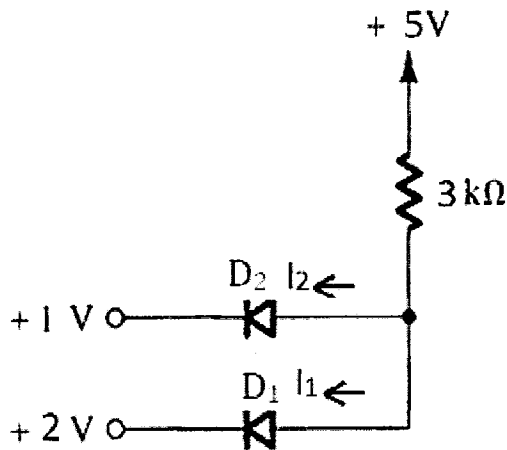
$$i_1 = 2.67\text{A and } i_2 = 1.55\text{A}$$

$$\therefore V_{\text{th}} = V_{\text{ab}} = 8i_1 + 10i_2 = 36.86\text{V}$$

Thevenin equivalent Circuit:



3. Assuming the diodes to be ideal, calculate the currents I_1 and I_2 in the circuit below.



Solution:

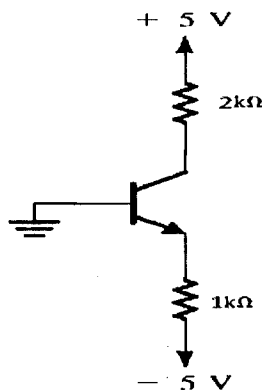
If $V \geq 2V$, Then all the diodes are forward biased and shorted. In this case 1V and 2V voltage is not possible, because at the same time there cannot have the same value of V. so, $V \geq 2V$ is no true.

If $2 > V \geq 1V$, Then D_2 diode will be forward biased and shorted and D_1 will be reverse biased and opened. Then, $V=1V$ is possible.

$\therefore V = 1V$ and $I_1 = 0$ (Answer)

$$I_2 = \frac{5-V}{3000} = \frac{5-1}{3000} = 1.33\text{mA (Answer)}$$

4. In the circuit below $V_{EB}=0.7V$; $\beta = 100$ and the BJT is operating in the active mode. Calculate the base, emitter and collector currents?



Solution:

Here, $V_{EB}=0.7V$

$$\text{We get, } I_E = \frac{V_{EE}-V_{EB}}{R_E} = \frac{5-0.7}{1} = 2.15\text{mA}$$

$$I_C = \frac{\beta}{1+\beta} I_E = \frac{100}{1+100} \times 2.15 = 2.13\text{mA}$$

$$I_B = I_E - I_C = 2.15 - 2.13 = 0.02\text{mA}$$

5. The core loss and copper loss of a 6.35/0.23KV single phase transformer are 50W and 125W respectively at 6.5W load. If the load is doubled what will be the efficiency of the transformer.

Solution:

Core loss, $P_{\text{core}} = 50\text{W}$; Full load core loss, $P_{\text{cu, full load}} = 125\text{W}$;

$$\therefore \text{Output, } P_{\text{out}} = VA_{\text{full load}} \times \text{p.f.} = 6.5\text{KW} = 6500\text{W}$$

Load, $x = \text{doubled} = 2$

$$\text{Efficiency at } x \text{ load} = \frac{x \times VA_{\text{full load}} \times \text{p.f.}}{x \times VA_{\text{full load}} \times \text{p.f.} + P_{\text{core}} + x^2 \times P_{\text{cu, full load}}}$$

$$\text{Efficiency at double} = \frac{2 \times 6500}{2 \times 6500 + 50 + 2^2 \times 125} = 0.9594 = 95.94\% \text{ (Answer)}$$

6. A 3 phase 4 pole, 50 Hz induction motor develops 10hp at 1000rpm. What will be the stator input if the stator loss is 100W?

Solution:

$$N_s = \frac{120f}{P} = \frac{120 \times 50}{4} = 1500\text{rpm}$$

$$S = \frac{N_s - N}{N_s} = \frac{1500 - 1000}{1500} = 0.3333$$

$$\frac{P_2}{P_m} = \frac{1}{1 - s}$$

$$P_2 = \frac{P_m}{1 - s} = \frac{7460}{1 - 0.3333} = 11189\text{W}$$

\therefore Stator input = Rotor input + Stator Losses

$$= 11189 + 100 = 11289\text{W} = 11.289\text{KW} \text{ (Answer)}$$

Here, $P = 4$, $f = 50\text{Hz}$,

$P_m = 10\text{hp} = 7460\text{W}$

$N = 1000\text{rpm}$

Stator loss = 100W

Rotor input = P_2

Stator input = ?

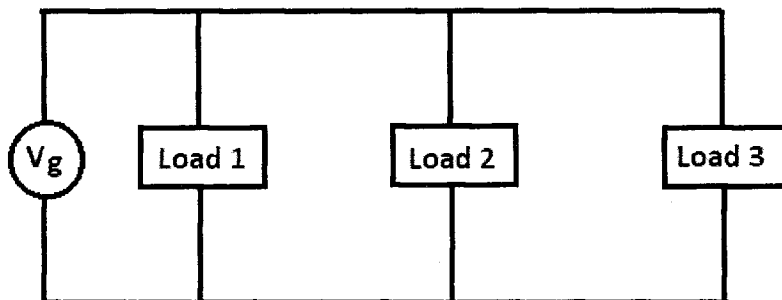
7. The three loads in the following 50 Hz circuits are:

Load 1: a 100Ω resistor in series with an inductance of 25.4 mH.

Load 2: a 120Ω resistor in series with a capacitance of 39.75 μF .

Load 3: a 60Ω resistor in series with another 80Ω resistor.

What is the power factor of the composite load?



Solution:

$$Z_{eq} = (100 + j 2\pi \times 50 \times 25.4 \times 10^{-3}) \parallel (120 + \frac{1}{j 2\pi \times 50 \times 39.75 \times 10^{-6}}) \parallel (60 + 80)$$

$$= (100 + j 7.98) \parallel (120 - j 80.07) \parallel 140 = 43.048 - j 5.784$$

$$\therefore \text{Power factor} = \frac{R_{eq}}{|Z_{eq}|} = \frac{43.048}{\sqrt{(43.048^2 + 5.784^2)}} = 0.999 \text{ (Answer)}$$

8. A 240V DC series motor takes 40A when giving its rated output at 3000rpm. Its resistance is 0.6ohm. Find what resistance must be added to obtain same torque at 2000rpm.

Solution:

SolutIn both cases, Torque remains constant. But, $T_a \propto I_a^2$. So, Armature current I_a will also remain constant (40A). If R is the series resistance added, then,

$$E_b = V_1 - I_a R_{\text{total}}$$

$$E_{b1} = V_1 - I_a R_1 = 240 - 40 \times 0.6 = 216 \text{ V}$$

$$\text{When, } N_1 = 3000 \text{ r.p.m.}$$

$$E_{b2} = V_1 - I_a R_2 = 240 - 40 \times (R + 0.6)$$

$$\text{When, } N_2 = 2000 \text{ r.p.m.}$$

As Armature current is remaining constant, $T_a \propto \frac{E_b}{N}$

$$\frac{E_{b1}}{N_1} = \frac{E_{b2}}{N_2}$$

$$\frac{E_{b2}}{E_{b1}} = \frac{N_2}{N_1}$$

$$\frac{240 - 40 \times (R + 0.6)}{216} = \frac{2000}{3000}$$

$$R = 1.8 \Omega \text{ (Answer)}$$

9. A pump discharge of water is $150 \text{ m}^3/\text{hr}$ at a height of 20 m. Find the pump output power in KW if the motor efficiency is 67.64%.
10. Write the application of following equipments:

Anemometer	used for measuring wind speed
Rotameter	flow rate of fluid in a closed tube
Pyrometer	Measures high temperatures, especially in furnaces and kilns
Dynamometer	measures the power output of an engine
Tachometer	measuring the rotation speed of a shaft or disk, as in a motor or other machine
[In another question set it was ask to]	
Manometer	measure pressures
Orifice meter	measure the rate of flow of Liquid or Gas, especially Steam

11. A 6 cylinder engine has a bore dia of 10 cm and stroke length 10 cm. Clearance volume is $50\pi \text{ cc}$. Find the compression ratio?
answer you, my, can't see
 [In another question set it was ask to "Find the displacement volume."]
12. Write the name of six major components of vapor absorption refrigeration.
13. Draw the T-S diagram of Rankine cycle and mention the thermodynamic processes.
14. Draw the p-h diagram of vapor compression refrigeration cycle and its thermodynamic process.
15. Draw the schematic diagram of pressure and velocity variation compounding in two stage steam turbine.

[All other questions are discussed already]

Bangladesh China Power Company (Pvt.) Limited (BCPCL)**Post: Assistant Engineer (Mechanical)****Time-3.00PM to 4.30 PM****Date: 22.12.2018****Exam Hall: BUET****[Non-departmental: 60×1=60; Departmental:40]**

1. Which one is the largest rice exporting country?
a) Indonesia **b) India** c) Thailand d) Vietnam
2. In which country Bangladesh export most?
a) USA b) Germany c) UK d) China
3. In which year China recognized Bangladesh as an independent country?
a) 1972 b) 1973 **c) 1975** d) 1976
4. Which one is the largest district of Bangladesh considering area?
a) Dhaka **b) Rangamati** c) Cox's Bazar d) Dinajpur
5. Which is per Capita income of population of Bangladesh?
a) 1325 **b) 1751** c) 1450 d) 1502
6. Which ocean is the largest one?
a) Pacific b) Atlantic c) Arctic d) Indian
7. What is the national fruit of Bangladesh?
a) Mango b) Banana **c) Jackfruit** d) Lemon
8. Which one is the largest carbon emitting country?
a) India **b) China** c) USA d) UK
9. Which one is the smallest country in Asia?
a) Srilanka **b) Maldives** c) Nepal d) Bhutan
10. Which country has the largest rainforest?
a) Brazil b) USA c) Peru d) Colombia
11. What is the design generation capacity of Kaptai Hydro power plant?
a) 200 MW b) 220 MW **c) 230 MW** d) 190 MW
12. What is the ratio of public & private electricity generation in Bangladesh?
a) 60:30 b) 50:50 **c) 55:45** d) 45:55
13. What is the maximum electricity generation in Bangladesh?
a) 18000 MW b) 10000 MW **c) 11500 MW** d) 9000 MW
14. What is per capita energy consumption in KWhr?
a) 200 KWhr b) 250 KWhr c) 300 KWhr **d) 350 KWhr**
15. In a synchronize machine no of pole = 4 & frequency = 50 Hz, what will be speed?
a) 1500 rpm
(Hints: $N = \frac{120f}{P} = \frac{120 \times 50}{4} = 1500 \text{ rpm}$)
16. Why high voltage transmission line is used?
a) To reduce transmission loss b) to increase efficiency c) to reduce capacitance **d) All of those**
17. Which fuel is used for producing more than 50% electricity in Bangladesh?

a) Coal **b) Natural gas** c) Oil d) HFO

18. The most common materials used in conductor?

a) Copper b) silicon c) Silver

19. Renewable energy contributes what percentage in total mix energy?

a) 3% b) 10% c) 8% d) 5%

20. Shunt Capacitance of transmission line affects which one?

a) Real power **b) Reactive power** c) Frequency d) None

21. $\log_{\sqrt{3}} 3 = 1/15$, what is y?

a) 243

22. Which number is divisible by 4,5,6 and every time remainder is 3?

a) 63

23. $a^3 - b^3 = 513$, $a - b = 3$, then $ab = ?$

a) 54 [Hints: $a^3 - b^3 = 513$ or, $(a - b)^3 + 3ab(a - b) = 513$ or, $3^3 + 3ab \times 3 = 513$ or, $ab = 54$]

24. Which country will leave OPEC in 1st January 2019?

a) Qatar b) Iraq c) Saudi Arabia d) Kuwait

25. If x,y are odd numbers then which one is even number?

a) xy b) x+y+1 c) xy-2 **d) x+y+2**

26. Which country will set free public transportation system from 2020?

a) Luxembourg b) Belgium c) Faroe Islands

27. The Ramon Magsaysay was in the name of former president of which country?

a) Philippines

28. The Ramon Magsaysay award is given for the contribution of which fields?

a) Literature

29. In a mixture milk & water ratio is 5:2, if milk is 6 Ltr. more than water, find how much Ltr. water?

a) 2 Ltr. b) 3 Ltr. **c) 4 Ltr.** d) 5 Ltr.

[Hints: M:W = 5:2 & M = W+6, So $\frac{W+6}{W} = \frac{5}{2} \Rightarrow 2w + 12 = 5W \therefore W = 4$]

30. কোন বানানটি অশুদ্ধ? **a) ত্রিগয়ন**

31. মতৈক্য এর সন্ধি বিচ্ছেদ? **a) মত + ঐক্য**

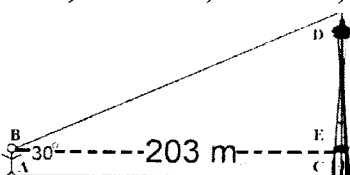
32. কোনটি কর্ম কারক আছে? **a) করিমকে যেতে হবে** b) বাঁশি বাজে

33. সনেট কোন ভাষার শব্দ? **a) ইতালি**

34. কোনটি দেশী শব্দ? **a) ডিঙ্গা**

35. An observer 1.6 m tall is $20\sqrt{3}$ away from a tower. The angle of elevation from his eye to the top of the tower is 30° . The heights of the tower is:

a) 21.6 m b) 23.2 c) 22.6 d) 19.3



[Hints: Tower CD = CE + DE = AB + $20\sqrt{3} \times \tan 30^\circ = 21.6$]

36. What is terminator II? **a) Movie**

37. Which one is odd: 8,27,64,100,125,216,343

a) 27 **b) 100** c) 216 d) 64

[Hints: $2^3=8$, $3^3=27$, $4^3=64$, $5^3=125$, $6^3=216$, $7^3=343$]

38. A motorboat, whose speed in 15 km/hr in still water goes 30 km downstream and comes back in a total of 4 hours 30 minutes. The speed of the stream (in km/hr) is:

(a) 4 **(b) 5** (c) 6 (d) 7

[Hints: if speed of stream = x, downstream speed = (15 + x) Km/hr, upstream = (15 - x) Km/hr. $\frac{30}{15+x} + \frac{30}{15-x} = 4\frac{1}{2}$ $\therefore x = 5$ Km/hr]

39. A tank is filled in 2 hrs but due to a leakage it takes 2 hour 20mins to fill the tank. How much time will it take to empty the tank?

a) 14 hr [2hrs 20mins = $2\frac{1}{3} = \frac{7}{3}$ hrs \therefore Work done by leak in 1 hour = $\frac{1}{2} - \frac{1}{\frac{7}{3}} = \frac{1}{2} - \frac{3}{7}$
 $= \frac{7-6}{14} = \frac{1}{14}$ then, total time to empty 14hrs.]

40. In a 300 m race A beats B by 22.5 m or 6 seconds. B's time over the course is-

(a) 86 **(b) 80** (c) 76 (d) 79

[Hints: B runs 22.5m in 6 seconds; so, he takes time for 300m = $\frac{300 \times 6}{22.5} = 80$ seconds]

41. He has been suffering ___ fever since Monday. (a) of **(b) from** (c) in (d) to

42. A circle radius is r, If it increases r+n, then the area of the circle fold 2 times. What is the value of r? **a) $r = \frac{n}{\sqrt{2}-1}$**

[Hints: $\pi(r+n)^2 = 2\pi r^2$ or, $(r+n)^2 = 2r^2$ or, $r+n = \sqrt{2}r$ or, $r = \frac{n}{\sqrt{2}-1}$]

43. Devoid of/with/at/in (preposition)?

44. How many ways the word "LEADER" can be arranged? Ans: **6P6/2 = 360**

45. If a card is taken randomly from 52 cards, what is the probability that the card will be an ACE or a KING or a QUEEN? Ans: **3/13**

46. Largest day of year in which month? Ans: **June**

47. Which country has started a hotline against smuggling with India? **a) Nepal**

48. To advice

49. He will leave the town _____. a) recently **b) immediately** c) lately

50. If a rhombus's two corner length is 4 & 6 cm, what is the area?

a) 2 cm² b) 6 cm² **c) 12 cm²** d) 24 cm²

[Note: Area of rhombus = $\frac{1}{2}$ * length of one corner * length of other corner]

51. Tiger wood is related to which sports? **a) Golf**

52. What is the sum of square of 1 to 9?

[Note: $1^2+2^2+3^2+4^2+5^2+6^2+7^2+8^2+9^2=285$]

53. Mr. Karim has returned _____ wallet back to its owner?

(a) a

54. Eight number has average value of 14. If first six of that number has average 16, what is the average of remaining two numbers?

a) 8 [Note: $(14 \times 8 - 16 \times 6)/2 = 16/2 = 8$]

55. How much time will it take for an amount of TK. 450 to yield TK. 81 as interest 4.5% per annum of simple interest? **a) 4**

$$[I = Pnr, n = \frac{I}{Pr} = \frac{81}{450 + (\frac{4.5}{100})} = 4]$$

56. A student's average mark is 84% in 4 exams. If he wishes to raise his average marks to 85% then what is the mark he should obtain in the 5th exam? **a) 89** [$85 \times 5 - 84 \times 4 = 89$]

57. A is 2 years older than B whose age is twice of C, the sum of ages of A, B & C is 27 then what is the age of B? **a) 10**

$$[A = B + 2, B = 2C \text{ now } A+B+C = 27 \text{ or } B+2+B+(B/2) = 27 \text{ or, } B = 10]$$

58. Tajmahal is located in ____? **a) Agra**

59. A number 60 is increased by 50% then decreased by x% which become 70. What is x?

a) 22.22%

$$[60 \times 1.5(1-x) = 70 \text{ or } x = 22.22\%]$$

Departmental

1. A power plant has peak load 75 MW. It has maximum connected load 45 MW, 30 MW, 20 MW & 10 MW. If plant capacity is 105 MW & load factor 0.6 then find i) average load ii) demand factor.

Solution:

Here, Maximum load = 75 MW; Connected load = $(45+30+20+10) = 105$ KW;

Plant capacity = 105 MW and Load factor = 0.6

We know,

$$\text{Load factor} = \frac{\text{Average load}}{\text{Maximum load}}$$

$$\Rightarrow \text{Average load} = \text{Load factor} \times \text{Maximum demand} = 0.6 \times 75 = 45 \text{ MW (Answer)}$$

Again,

$$\text{Demand factor} = \frac{\text{Maximum demand}}{\text{Connected load}} = \frac{75}{105} = 0.714 \text{ (Answer)}$$

2. A heat transfer equation is written below:

$$r \frac{d^2 T}{dr^2} + 2 \frac{dT}{dr} = 0$$

Which conditions are applicable for this equation?

Heat transfer	Plate/cylinder/Sphere
Dimension	1D/2D/3D
State	Transient/Steady
Heat generation	No/Yes

N.B. The Bold words indicates the answer for above table

3. A steel casting cools to 90 percent of the original temperature difference in 30 min in still air. How much time it should require to cool this same casting to 90 percent of the original temperature difference in a moving air stream whose convective heat transfer coefficient is 5 times that of still air?

Solution: Here, $t_1 = 30 \text{ min}$; $t_2 = ?$ $h_2 = 5h_1$

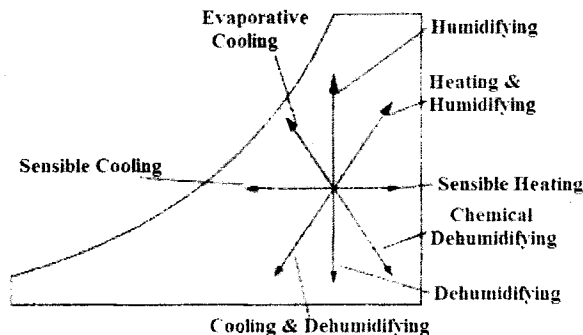
We get, $Q_1 = Q_2$

$$\Rightarrow h_1 A \Delta T \cdot 30 \text{ min} = h_2 A \Delta T \cdot t_2$$

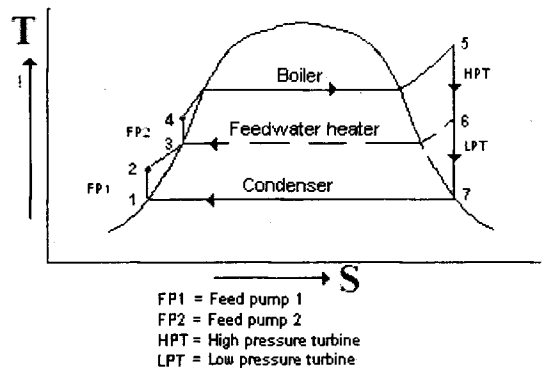
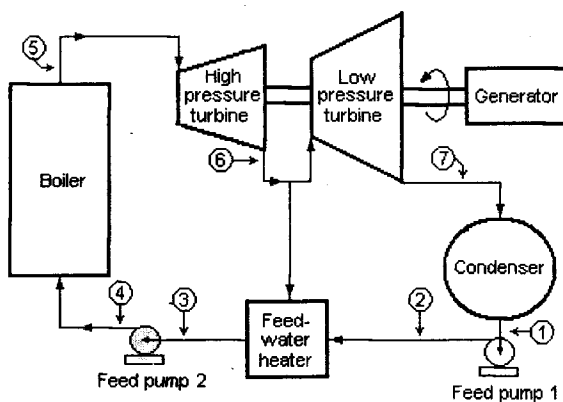
$$\Rightarrow h_1 A \Delta T \cdot 30 \text{ min} = 5h_1 A \Delta T \cdot t_2$$

$$\therefore t_2 = 6 \text{ mins (Answer)}$$

4. Show different process on a psychrometric chart i) heating & humidification ii) Sensible heating iii) Chemical dehumidification iv) Evaporative cooling.



5. Draw T-S of Rankine cycle for the given figure.



6. A submersible pump has a head of 40.5m, discharge of 25L/s. Rating for running of the pump is: 3 ϕ AC supply, 22A, 400V, pf 0.95, Find efficiency of the submersible pump.

Solution: Given that, $H = 40.5\text{m}$, $Q = 25\text{L/s} = 0.025\text{ m}^3/\text{s}$, $I = 22\text{ A}$, Voltage, $V = 400\text{ V}$, $\text{pf} = \cos \theta = 0.95$

Pump input power, $P = \sqrt{3}VI \cos \theta = \sqrt{3} \times 400 \times 22 \times 0.95 = 14479.94\text{W}$

$$\therefore \text{Efficiency, } \eta = \frac{\gamma HQ}{P}$$

$$= \frac{9.81 \times 100 \times 40.5 \times 0.025}{14479.94}$$

$$= 68.59\% \text{ (Answer)}$$

7. Both end-hinged column 1m Length, 20 \times 30 mm. Find flowing parameters:

- (i) Second moment of inertia, (ii) Radius of gyration (iii) Slenderness ratio and (iv) Critical buckling load

Solution:

(i) Second moment of inertia, $I = \frac{bh^3}{12} = \frac{20 \times 30^3}{12} = 45000\text{ mm}^4 \text{ (Answer)}$

- (ii) Radius of gyration, $k = \sqrt{\frac{I}{A}} = \sqrt{\frac{45000}{20 \times 30}} = 8.66 \text{ mm (Answer)}$
- (iii) Slenderness ratio, $\frac{L}{K} = \frac{1000}{8.66} = 115.47 \text{ (Answer)}$
- (iv) Critical buckling load $P_{cr} = \frac{N\pi^2 EL}{l} = \frac{1 \times \pi^2 \times 200 \times 10^9 \times 45000 \times 10^{-9}}{1000} = 88826.855 \text{ N (Answer)}$

8. Write three major differences between planner machine and shaper machines.

Answer:

Shaper machine	Planner machine
(i) In shaper machine, tool is the moving part and work piece remains stationary.	(i) In planner machine, work piece is the moving part and tool remains stationary.
(ii) It can use only one cutting tool at a time.	(ii) It is equipped more than one cutting tool at a time.
(iii) Shaper is used quick return mechanism to drive the ram. In modern machine, hydraulic drive is also used.	(iii) Planer is driven by gear or hydraulic arrangement.

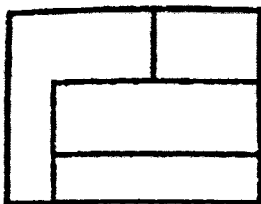
9. A circular test bar specimen of diameter of 80 mm & length 600 mm is subjected to elongation test. Test result shows:— gauge length 200 mm, Yield load 225KN, braking load 242 KN, final length after elongation 249 mm. Find the braking strength and percent of elongation?

Solution: Given that, $d = 80 \text{ mm}$, $L = 600 \text{ mm}$, Gauge length, $L_g = 200 \text{ mm}$, Braking load = 242 KN, Final length after elongation, $L_e = 249 \text{ mm}$

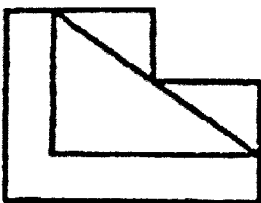
We get, Breaking strength = $\frac{\text{Breaking load}}{\text{Cross sectional area}} = \frac{242 \times 1000}{\frac{\pi}{4} \times (0.08)^2} = 48.14 \text{ MPa (Answer)}$

Again, Percentage of elongation = $\frac{L_e - L_g}{L_g} = \frac{249 - 200}{200} = 24.5\% \text{ (Answer)}$

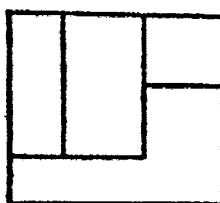
10. Draw TOP View, FRONT View & RHS View.



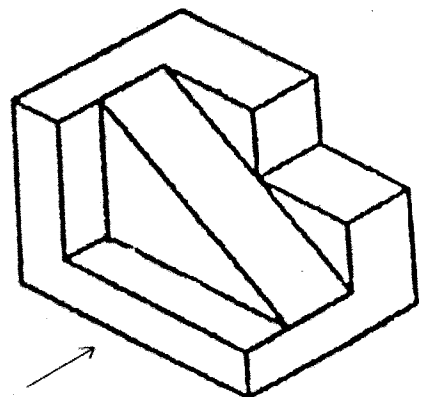
TOP VIEW



FRONT VIEW



RHS VIEW

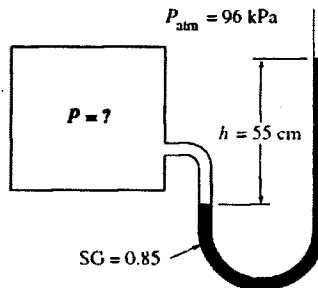


Bangladesh Inland Water Transport Authority (BIWTA)**Post: Assistant Engineer(Mechanical)****Time-10.00AM to 11:30PM****Date:08.02.2019 Exam Hall: BUET****Non-Departmental**

1. টি, টা, খানা, খানি কে কি বলে? - **পদ্যপ্রিত নির্দেশক**
2. বাংলা সাহিত্যের প্রথম ইতিহাস গ্রন্থ রচনা করেন কে? - **দীনেশ চন্দ্র সেন**
3. "গিন্নী" কোন শ্রেণীর শব্দ?
ক. খাঁটি বাংলা খ. দেশী গ. বিদেশী ঘ. অর্ধতৎসম
4. কোনটি 'বাতাস' শব্দের সমার্থক নয়?
ক. পাবক খ. মারুত গ. পবন ঘ. অনিল
5. লাঠিতে লাঠিতে যে লড়াই-লাঠালাঠি কোন সমাস?
ক. দ্বন্দ্ব খ. কর্মধারয় গ. বহুব্রীহি ঘ. তৎপুরুষ
6. নিচের কোনটি রবীন্দ্রনাথ ঠাকুরের লেখা উপন্যাস?
7. বীরবল কার ছদ্মনাম? ক) রবীন্দ্রনাথ ঠাকুর খ) সমরেশ বসু গ) প্রমথ চৌধুরী
8. কোনটি সঠিক বানান? (ক) নিশিথিনী, (খ) নীশিথিনী, (গ) নিশীথিনী (ঘ) নিশিথিনি
9. দ্বীপায়ন এর সন্ধি-
ক. দ্বীপ + আয়ন খ. দ্বিপ + অনট
গ. দ্বীপ + অয়ন ঘ. দ্বীপ + অনট
10. অর্ধ মাত্রার বর্ণ কয়টি? - **৮টি**
11. অক্ষির সমীপে এর সংক্ষেপণ হল-
ক. সমক্ষ খ. পরোক্ষ গ. প্রত্যক্ষ ঘ. নিরপেক্ষ
12. মল্লয়া পালার রচয়িতা - **দ্বিজ কানাই**
13. Where Tanguar haor is located? - **Sunamganj**
14. How many cricketers have double century in test cricket by Bangladesh? - **08**
15. অপারেশন জ্যাকপট কবে সংগঠিত হয়? - **১৬ আগস্ট প্রথম প্রহরে**
16. Length of Padma Bridge- **6.15Km.**
17. Current Secretary-General of the United Nations is from? - **Portuguese.**
18. বাংলাদেশকে স্বীকৃতি প্রদানকারী প্রথম ইউরোপীয় দেশ কোনটি? ক) যুক্তরাজ্য খ) পোল্যান্ড
গ) স্পেন ঘ) গ্রীস
19. What is the Capital of Croatia? - **Zagreb**
20. Bangladesh air force founded at? - **1971**
21. "Hasina: A Daughter's Tale" is directed by- **Piplu Khan**
22. The 2020 Olympics will be held in - **Tokyo.**
23. Currency name of Vietnam- **Vietnamese dong**
24. 'Ins and Outs' means- **The intricate details of a situation or process**
25. What type of noun is "Girl"? - **common**
26. Active form of 'what cannot be cured, must be endured.' - **You must endure what you cannot cure.**
27. Synonyms of 'imbibe'- **drink, consume, sup**
28. Synonyms of 'Plebiscite'- **vote, referendum, ballot, poll**
29. Antonyms of supercilious- **humble, modest**
[বাকি প্রশ্নগুলো সংগ্রহ করা যায়নি।]

Departmental

1. A manometer is used to measure the pressure in a tank. The fluid used has a specific gravity of 0.85, and the manometer column height is 55 cm, as shown in Figure below. If the local atmospheric pressure is 96 kPa, determine the absolute pressure within the tank.



Solution:

$$\rho = 0.85 \times 1000 = 850 \text{ Kg/m}^3$$

$$P = P_{\text{atm}} + \rho gh = 96 + \frac{850}{1000} \times 9.81 \times 0.55 = 100.6 \text{ KPa} \quad (\text{Answer})$$

2. Match the following number

Answer

a	Reynold Number	(i)	$\frac{\mu C_p}{k}$	a	(iii)
b	Biot Number	(ii)	$\frac{W}{\sqrt{gL}}$	b	(v)
c	Froude Number	(iii)	$\frac{VL}{v}$	c	(ii)
d	Prandtl Number	(iv)	$\frac{\mu}{\rho D_{AB}}$	d	(i)
e	Schmidt Number	(v)	$\frac{hL}{K}$	e	(iv)

3. The food compartment of a refrigerator is maintained at 4°C by removing heat from it at a rate of 360 kJ/min. If the required power input to the refrigerator is 2 kW, determine (a) the coefficient of performance of the refrigerator and (b) the rate of heat rejection to the room that houses the refrigerator.

Solution:

$$(a) Q_L = 360 \text{ Kj/min} = \frac{360}{60} \text{ KW} = 6 \text{ KW}$$

$$\text{COP} = \frac{Q_L}{W_{\text{in}}} = \frac{6}{2} = 3 \quad (\text{Answer})$$

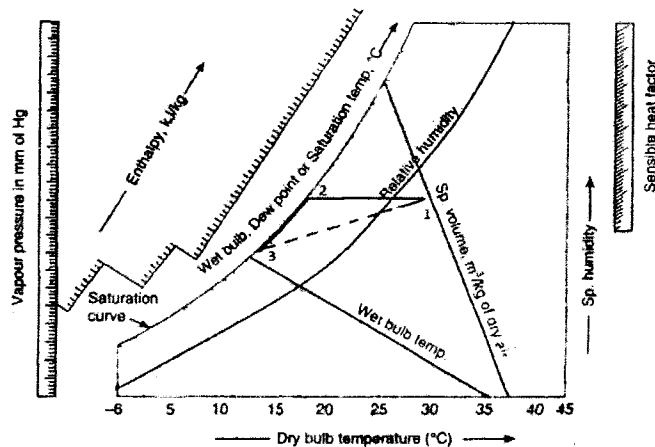
$$(b) W_{\text{in}} = Q_C - Q_L$$

$$\Rightarrow 2 = Q_C - 6$$

$$\Rightarrow Q_C = 8 \text{ KW} \quad (\text{Answer})$$

4. Draw a psychrometric chart and schematically show the cooling process of room air in indoor split-type air conditioning system.

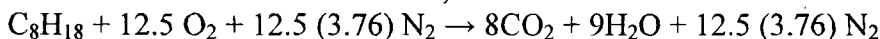
Solution:



Here, the processes (1-3) involve in the indoor unit of a split air conditioning system (i.e. Cooling and dehumidification)

5. **Isooctane is burned with 120% theoretical air in small three cylinder turbocharged automobile engine. Calculate Air Fuel ratio.**

Solution: Stoichiometric reaction,



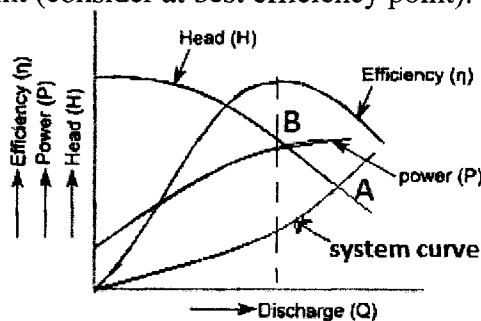
With 20% excess air,



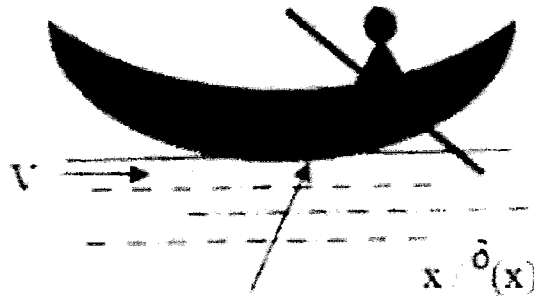
$$\text{Air-Fuel ratio} = \frac{A}{F} = \frac{M_a}{m_f} = \frac{N_a M_a}{N_f M_f} = \frac{15 \times 4.76 \times 29}{1 \times 114} = 18.16 \text{ (Answer)}$$

6. **Draw a characteristic (performance) curve of a centrifugal pump, also draw a demand curve on same graph showing operating and design point on this curve.**

Answer: Here, Point A is the operating point (where system curve and head curve meets; system curve is a function of elevation or static head including major and minor losses). Point B is the **design** point (consider at best efficiency point).



7. **A canoe moving on a surface of lake water where water is at 40°C and canoe moves at 5 Km/hr, which length is 5m, which is flat; Is the boundary layer is laminar on turbulent on the bottom of canoe surface? ($T = 40^\circ\text{C}$, $\gamma = 0.6579 \times 10^{-6} \text{ m}^2/\text{s}$).**



Boundary layer

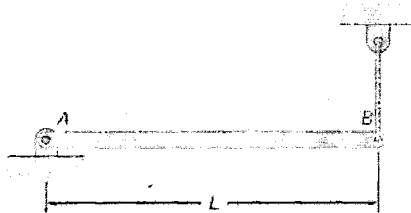
Solution: Here, $V = 5 \text{ Km/hr} = \frac{5 \times 1000}{3600} \text{ m/s} = 1.389 \text{ m/s}$

$$R_{eN} = \frac{VL}{\nu} = \frac{1.389 \times 5}{0.6579 \times 10^{-6}} = 12991050.02 \approx 10.55 \times 10^6$$

$$\therefore R_{eN} > 5 \times 10^5$$

So, Boundary layer is turbulent. (Answer)

8. A uniform rod of length L and mass m is supported as shown. If the cable attached at end B suddenly breaks, determine the angular acceleration of AB.



Solution:

$$\text{Here, } \omega = 0; \bar{a} = \frac{L}{2} \alpha$$

$$\sum M_A = \sum (M_A)_{\text{eff}}$$

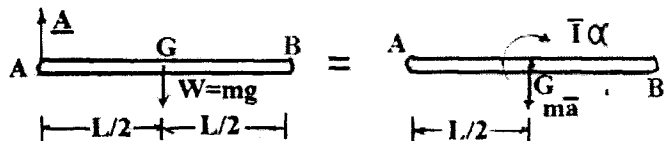
$$\Rightarrow W \frac{L}{2} = \bar{I} \alpha + m \bar{a} \frac{L}{2}$$

$$\Rightarrow mg \frac{L}{2} = \frac{1}{12} mL^2 \alpha +$$

$$m \left(\frac{L}{2} \alpha \right) \frac{L}{2}$$

$$\Rightarrow mg \frac{L}{2} = \frac{1}{3} mL^2 \alpha$$

$$\Rightarrow \alpha = \frac{3g}{2L} \sim$$



9. From the following figure, determine the block will be equilibrium or not?

Where, $\mu_s = 0.4$, $\mu_k = 0.3$



Solution:

$$\rightarrow + \sum F_y = 0$$

$$N = 9.81m \times \cos 25^\circ$$

$$= 8.89m \text{ N}$$

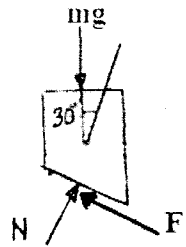
$$F_m = \mu_s N = 0.40 \times 8.89m = 3.55m \text{ N}$$

$$\leftarrow + \sum F_x = 0$$

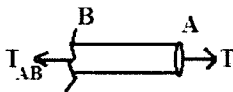
$$F = 9.81m \times \sin 25^\circ$$

$$= 4.145m \text{ N}$$

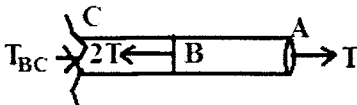
As, $F > F_m$, So the block will not equilibrium. (Answer)



10. A shaft shown in figure below, which diameter is 25 mm, length is 1 m. Determine the maximum shear stress and angle of twist of the shaft. Where, Shear modulus is 80 GPa.

Solution:Internal Torque for section AB:

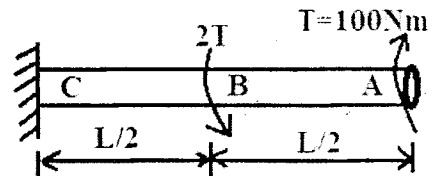
$$T_{AB} = T$$

Internal Torque for section BC:

$$T_{BC} = 2T - T = T$$

$$\therefore \tau_{\max} = \frac{16T}{\pi D^3}$$

$$= \frac{16 \times 100}{\pi \times (25 \times 10^{-3})^3} = 32.6 \text{ MPa (Answer)}$$

Angle of Twist:

$$\theta = \sum \frac{TL}{JG} = \left(\frac{TL}{JG}\right)_{AB} - \left(\frac{TL}{JG}\right)_{BC} = \frac{T}{JG} \left(\frac{L}{2} - \frac{L}{2}\right)$$

$$= 0 \text{ (Answer)}$$

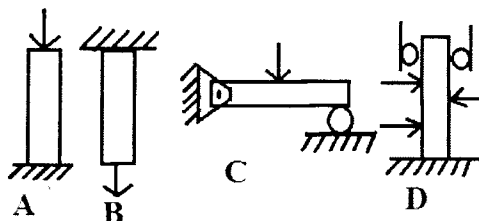
11. A turbine rotor of ship has a mass of 8000 Kg, radius of gyration is 0.5 m and rotates 180 rad/s. Clockwise it has speed of 25m/s take left turn in a curved path has radius of 100m. Determine the gyroscopic couple and its effect.

Solution: We Get, $C = I\omega\omega_p = m k^2 \times \omega \times \frac{v}{R}$

$$= 8000 \times 0.5^2 \times 180 \times \frac{25}{100} = 90 \text{ KNm (Answer)}$$

When the rotor rotates clockwise, when looking from the stern and the ship takes a left turn, the effect of the reactive gyroscopic couple is to raise the bow and lower the stern.

12. Write the name of structural member based on loading and fixing.





Answer: (A) One end fixed member and compression load.

(B) One end fixed member and tensile load.

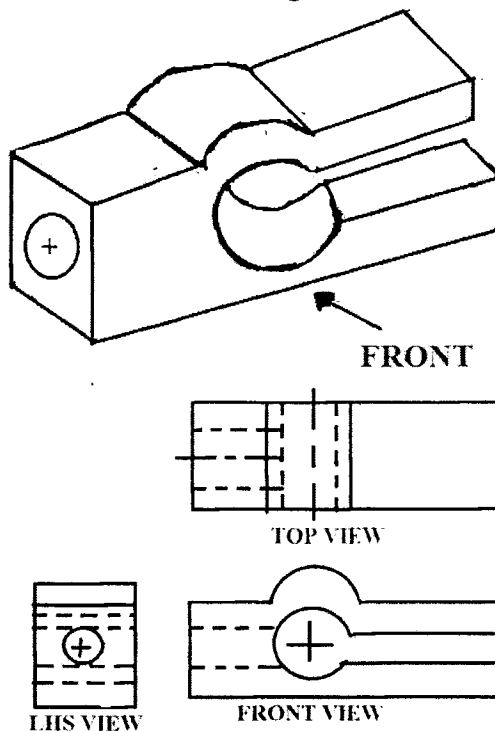
(C) One end pinned and other end roller with point load.

(D) Both end fixed with compression load.

13. From following figure write the types of failure and loading.

(i) Missing	(ii) Missing	(iii) 	(iv) 
		Failures of Ductile materials under compression.	Failures of Brittle materials under compression.

14. Draw orthographic view from the following isometric view.



Nuclear Power Plant Company Bangladesh Limited(NPCBL)**Post: Executive Trainee (Engineer)****Time-03.00PM to 04:30PM****Date:30.11.2018****Exam Hall: ECE Building, BUET.**

Marks: Non departmental MCQ (0.5×20)=10; Departmental MCQ (1×40)=40;
Written=50

Non departmental MCQ

1. Please, come here. Here “please” which parts of speech?
a) adjective b) pronoun c) adverb d) preposition
2. When Sikkim was merged with India ?
a) 1971 b) 1973 c) 1974 d) **1975**
3. When did China recognized Bangladesh as an independent country?
a) 1971 b) 1972 c) 1973 d) 1974
4. Dhaka was situated in which sector during liberation war of Bangladesh?
a) **sector 2** b) sector 4 c) sector 8 d) sector 11
5. Which countries are related with Sunshine policy?
a) USA & UK b) **North & South Korea** c) India and Pakistan d) Canada and France
6. National animal of Bangladesh is ?
a) Deer b) **Tiger** c) Lion d) Cow
7. Largest district of Bangladesh considering area ?
a) **Rangamati** b) Comilla c) Dhaka d) Barishal
8. লাজ কোন পদ? a) বিশেষ্য b) বিশেষণ c) সর্বনাম d) ক্রিয়া বিশেষণ
9. চর্যাপদের আদি কবি কে? a) কাহুপা b) **লুইপা** c) ভুসুকুপা শবরপা
10. Which country has made Bangla as state language except Bangladesh?
a) Japan b) **Syria liyan** c) Africa d) USA
11. “The Wings of Fire” what type of literature it is?
a) poem b) play c) **autobiography** d) Drama
12. সে না আসবে না? না কি অর্থে ব্যবহার করা হয়েছে? সম্ভাবনা
13. হাতভারি বাগধারার মানে কি? **কপণ**
14. কোনটি সঠিক? আমি চাক্ষুস দেখেছি।
15. What is per Capital income (\$) of Bangladesh?
a) 1450 b) 1520 c) 1751 d) 1800
16. What is the adjective of “Tax” ?
a) Taxability b) **Taxable** c) Taxation d) Taxing
17. You should rather go there, -----? a) b) c) d)
18. Which nuclear power plant of Japan faced great disaster in 2011?
a) **Fukushima**

19. He was injured by--- fever?
 a) huge b) much **c) severe** d) little
 20. What is the meaning of out and out?
 a) end point **b) thoroughly** c) Outside d) None

Departmental MCQ

1. Degree of reaction of impulse turbine is ?
a) 0 b) 1 c) 0 to 0.5 d) 0.5 to 1
 2. The relationship of gross stage efficiency with nozzle efficiency and blade efficiency of impulse turbine is .
a) $\eta_s = \eta_b \times \eta_n$ b) $\eta_s = \frac{\eta_b}{\eta_n}$ d) $\eta_s = \eta_b + \eta_n$ d) $\eta_s = \eta_b - \eta_n$
 3. What is the Hydraulic diameter of a 10cm × 10cm rectangular block ?
 a) 20cm b) 7.5cm **c) 15cm** d) 12cm
 4. In a condenser inlet temperature 15°C and outlet temperature 25 °C . If steam temperature at outlet at certain pressure is 38°C then what is the efficiency of that condenser?
 a) 23.6% b) 46% **c) 43.5%** d) 56%
 5. Three compressors are connected in series . Each of them has compression ration 2 , if inlet pressure in the first compressor is 150KPa , what will be the outlet final pressure ?
 a) 300KPa b) 450KPa c) 750KPa **D) 1200KPa**
 6. For a thin wall pressure cylinder what will be the ratio of longitudinal stress and hoop stress?
a) $\frac{1}{2}$ b) 1 c) 2 d) 4
 7. If pressure inside a pipe measured as 0.2 bar vacuum , then what is the absolute pressure?
 a) 1 bar b) 0.6 bar **c) 0.8 bar** d) 1.2 bar
 8. If height of a pond is 10 m , then what will be the absolute pressure in the bottom?

Ans: 199.425 KPa.

9. Which type of reactor does not need a heat exchanger ?
 a) PWR **b) BWR**
 10. In a 5 m tank there is a leakage in the bottom, what will be velocity of fluid in the bottom?

Ans: 9.9 m/s

11. A member is called strut when it is subjected to ----- loading? Ans : Compressible
 12. Universal testing machine can be used for testing ---?

Ans: Tension, Compression , Shear & bending.

13. What fuel is used for Fast Breed Reactor?

Ans: 90% U238 and 10% U235

14. Which kind of nuclear reactor is used in most of the nuclear power plant?

a) PWR b) **BWR**

15. If compressor work 300 KJ/kg and turbine work 700 KJ/kg and heat added 1250 KJ/kg . What will be the gas turbine efficiency?

Ans: 32%

16. Which one is not considered as boiler mountings?

a) Water level indicator b) Safety valve c) **Economizer** d) Fusible plug

17. Air flowing at 200 m/s , -50°C , what is Mach number?

Ans: 0.668

18. Which one is used for measuring velocity of flowing liquid inside pipe?

a) **Orifice** b) **Pitot tube** c) V notch d) Anemometer

19. Why shield is used in reactor?

Ans: To reduce the radiation exposure.

20. Given temperature 30°C & 100°C , $h=200 \text{ W/m}^2\text{k}$, what is Q in MW/m^2

Ans: 0.014 MW/m²

21. conduction related math

22. convection related math

23. If diameter of a pipe is measured to be 20 ± 5 , then what is the value of Tolerance?

a) 0.5 b) -0.5 c) 2 d) **1**

24. The energy stored in a body when strained within elastic limit is known as

a) **Modulus of resilience** b) strain energy
c) modulus of toughness d) impact energy

25. A machine part is designed as a strut , when it is subjected to

a) an axial tensile force b) a tangential force
c) **an axial compressive force** d) any one of the above

26. The type of steel used for marking cutting tool is

a) Mild steel b) **High carbon steel** c) Medium carbon steel d) low carbon steel

27. The ability of a material; to resist wear is called

a) strength b) **hardness** c) toughness d) brittleness

28. The resistance to crack propagation of a material is known as

a) strength b) hardness c) **fracture toughness** d) brittleness

29. The progressive plastic deformation at constant load over a long period is known as

a) plasticity b) fatigue c) resilience d) **creep**

30. The curve of stress Vs number of cycles to failure is plotted for

a) tensile test b) shear test c) hardness test d) **fatigue test**

31. When two identical helical springs are connected in series , the resulting spring stiffness

a) increases b) **decreases** c) remain same d) none of a & c

32. The coefficient of static friction is

- a) smaller than coefficient of kinetic friction b) smaller than coefficient of kinetic friction
c) greater than coefficient of kinetic friction d) half of the coefficient of kinetic friction
33. The close-coiled helical springs A and B of same material, same coil diameter, same wire diameter, subjected to same load. If the number of turns of spring A is half of spring B . the ratio of deflection of spring A to spring B is
 a) $\frac{1}{2}$ b) 1 c) 2 d) 4
34. The average tensions on the tight and slack side of a belt drive system are 700N and 400N respectively . If the linear velocity of belt is 5 m/s , the power transmitted by the system would be about :
a) 1.5 KW b) 3 KW c) 5 KW d) 10 KW
35. A reverted gear train is one in which the output and input shafts
 a) rotate in opposite direction b) are at right angle to each other
c) rotate in same direction co-axial d) are at 45 angles to each other
36. In a flat belt drive , the belt is subjected to maximum tension T and a centrifugal tension T_c . For maximum power transmission
 a) $T=T_c$ b) $T= 2T_c$ **c) $T=3T_c$** d) $T=4T_c$
37. The natural frequency of a system . which has equivalent spring stiffness of 30000 N/m and mass of 20 kg is
 a) 12.32 Hz b) 4.10 Hz **c) 6.16 Hz** d) None of the above

Written

1. Fill in the following table.

Mode	Mechanism	Empirical Law and Equation	Transport Property
Conduction	Energy Transfer due to molecular/atomic activity	$Q = -KA \frac{dT}{dx}$ Fourier's Law	Conductivity, K
Convection	Energy Transfer due to molecular motion and bulk fluid motion	$Q = hA(T_1 - T_2)$ Newton's Law of Cooling	h = Co-efficient of convective heat transfer
Radiation	Energy Transfer due to exchange of electromagnetic waves	$Q = \epsilon \sigma A(T_1^4 - T_2^4)$ Stefan-Boltzmann Law	ϵ = emissivity

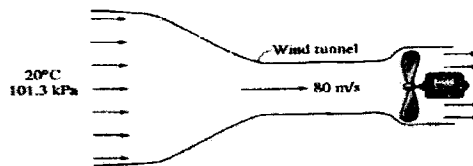
In the above question bold marks were blank. These bold marks were used for indicating answers.

2. A centrifugal pump delivers $0.6 \text{ m}^3/\text{s}$ of water against a total height of 25m. The internal diameter of the pipe is 10cm and it is 30m long. If the overall efficiency of the pump is 65%. Calculate the power needed to drive the pump. Assume the friction factor coefficient is $f = 0.054$.

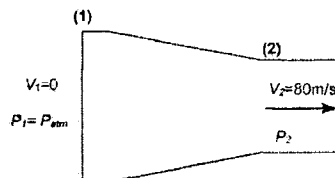
Solution: [Similar to GTCL-2018]

Hints: $V_s = V_d = V = \frac{Q}{A}$; $H_m = H + \frac{fV^2}{2gd} + \frac{v_d^2}{2g}$; $\therefore P = \frac{\rho g Q H_m}{\eta}$

3. A wind tunnel draws atmospheric air by a large fan. For a given air velocity as shown in the figure, the pressure in the tunnel is to be determined. The gas constant of air is $0.287 \text{ KPa m}^3/\text{Kg.K}$.



Solution:



$P_1 = 101.3 \text{ KPa}$; $R = 0.287 \text{ KJ/Kg.K}$; $T_1 = (20 + 273.14) = 293.14 \text{ K}$;

$\rho_1 = \frac{101.3}{0.287 \times 293.15} = 1.204 \text{ Kg/m}^3$

Apply Bernoulli's equation between the points (1) and (2).

$$\Rightarrow \frac{p_1}{\rho} + \frac{v_1^2}{2} = \frac{p_2}{\rho} + \frac{v_2^2}{2}$$

$$\Rightarrow \frac{101.3 \times 10^3}{1.204} + 0 = \frac{p_2}{1.204} + \frac{(80)^2}{2}$$

$\Rightarrow P_2 = 97.446 \text{ KPa (Answer)}$

4. What are the three major categories of low level radioactive waste in a nuclear power plant? Give at least two examples of the waste in each category.

Answer: Three major categories of low level radioactive waste in a nuclear power plant are:

Class A (Low Concentrations): Contaminated protective clothing, paper, trash.

Class B (Higher concentrations, usually activity 10-40 times greater than class A): Resins and filters.

Class C (Higher concentrations, usually activity 10-100 times greater than class B): Reactor components, sealed sources

References:

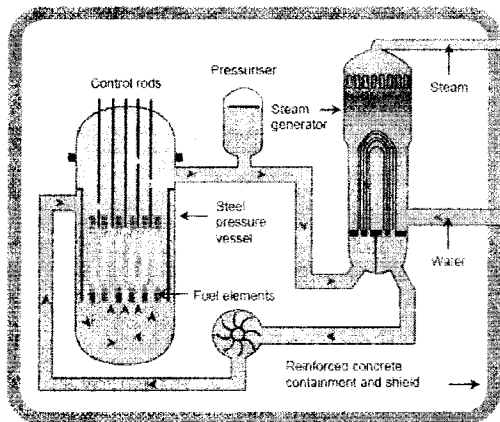
<https://www.nrc.gov/docs/ML0706/ML070600684.pdf>

<https://ieer.org/resource/classroom/classifications-nuclear-waste/>

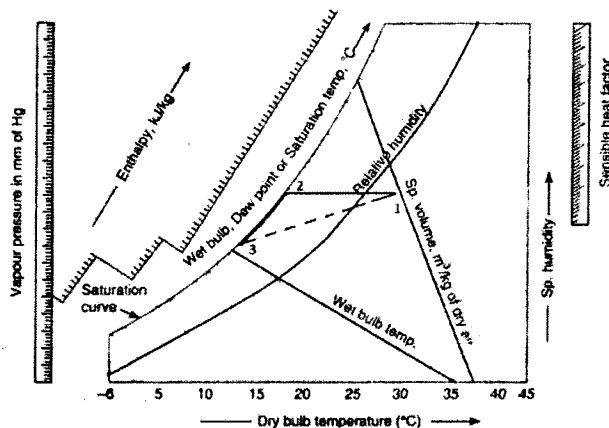
5. What type of power generating technology has been chosen for Rooppur power plant? Draw the schematic diagram of the nuclear reactor to be installed in the plant and label its major components.

Answer: For Rooppur power plant, PWR (Pressurized Water Reactor) is chosen which model is VVER-1200 ("Voda Voda Energo Reactor" Russian word) or WWER- 'water-water energy reactor' (i.e. water-cooled water-moderated energy reactor)

Schematic diagram of the PWR nuclear reactor:



6. Draw the psychrometric chart schematically and show the processes that are must involve in the indoor unit of a split air conditioning system.



Here, the processes (1-3) involve in the indoor unit of a split air conditioning system (i.e. Cooling and dehumidification)

7. A mass of $m=10$ kg is suspended by a spring of stiffness of $k=1$ KN/m from a fixed support. The mass vibrates freely with amplitude of 0.008 m. Ignore the effect of damping and mass of the spring. Calculate (a) the maximum restoring force. (b) the natural frequency.

Solution:

(a) The maximum restoring force:

$$\begin{aligned}\text{Maximum restoring force} &= - \text{spring inertia force} \\ &= -k\delta = 1000 \times 0.008 = 8\text{N} \text{ (Answer)}\end{aligned}$$

(b) Natural frequency:

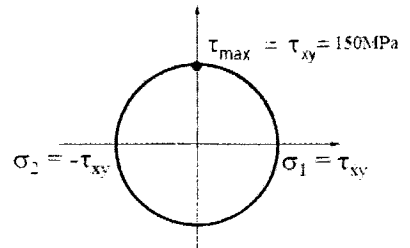
$$\begin{aligned}f &= \frac{1}{2\pi} \sqrt{\frac{k}{m}} = \frac{1}{2\pi} \sqrt{\frac{1000}{10}} \\ &= 1.592 \text{ Hz (Answer)}\end{aligned}$$

8. A shaft is applied with a torsional force. Shear force develops 150MPa on the surface of the shaft. Draw the Mohr circle. Write the equation for the principal shear forces. Consider 2D principal plane.

Principal stresses:

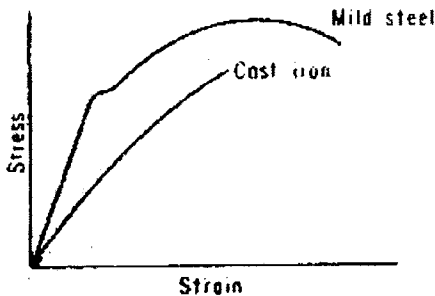
$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (\tau_{xy})^2}$$

The plus sign is used for the larger stress and the minus sign for the smaller stress.



9. In a same tensile stress-strain diagram show the graph for (i) CI material and (ii) MS material

Answer:



10. A machine element is subjected to fluctuating load has following data: ultimate tensile strength of 750MPa, fully connected endurance limit of 200MPa, alternating stress of 190MPa, mid-range stress of 110MPa. Find safety factor guarding against fatigues failure using modified Goodman equation.

Solution: Given, Ultimate tensile strength, $S_{ut} = 750\text{MPa}$, fully connected endurance $S_e = 200\text{MPa}$, alternating stress $\sigma_a = 190\text{MPa}$, mid-range stress, $\sigma_m = 110\text{MPa}$

According to modified Goodman equation:

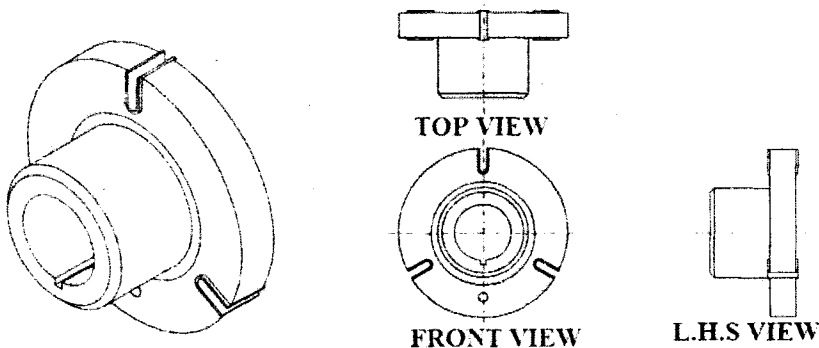
$$\begin{aligned}\frac{\sigma_a}{S_e} + \frac{\sigma_m}{S_{ut}} &= \frac{1}{n} \\ \Rightarrow \frac{190}{200} + \frac{110}{750} &= \frac{1}{n}\end{aligned}$$

$$\therefore n = 0.912 \text{ (Answer)}$$

11. A steel thin wall pressure vessel has the mean radius is 40mm and the thickness is 20mm. The internal pressure is 25MPa. Find the (i) longitudinal stress (ii) hoop stress and (iii) maximum shear stress.

Solution: Same as Previous year question

12. Draw the necessary view; consider the front view at the side of the key ways.



Dhaka Electricity Supply Company Limited (DESCO)

Post: Assistant Engineer(Mechanical)

Time-3.00PM to 4.30 PM

Date: 29.03.2019

Exam Hall: BUET

[Non-departmental: 60×1=60; Departmental:40]

- DESCO have no (a) Power plant (b) Substation (c) Cable
- Captive power plant? **Answer : Captive power plant is a dedicated to provide energy for a single user.**
- Which common type dual fuel not use in Bangladesh?
(a) **Coal & gas** (b) Gas & Diesel (c) None of these.
- Primary fuel of Dual Power Plant ? (a) **Gas** (b) Steam (c) Coal
- Which one is prime mover generator?
(a) Engine (b) Steam turbine (c) Gas Turbine (d) **All of these.**
- What is the purpose of using oil in Transformer? (a) **cooling and Insulation**
- Which type of meter not used in Bangladesh?
(a) Prepaid meter (b) Digital meter (c) Postpaid meter (d) Disk type meter
- A CFL lamp 230V and 0.2 amps?
(a) **Power equal to 46W** (b) More than 46W
(c) Less than 46W (d) All values are wrong.
- Which one is the biggest Power Plant ? (a) **Paiara** (b) Ruppur (c) Matarbari.
- Commissioning date of Nuclear Power Plant ? (1st)
(a) 2021 (b)2022 (c) **2023** (d) 2024

11. Average of ten number is 45, Added 5 with each other number then multiplied with 3.
Which is the average of ten number?
(a) 45 (b) **150** (c) 145
12. Load shedding done with?
(a) Nearest pole (b) Substation end (c) **Consumer end**
13. Which one cable is not used in Bangladesh?
(a) 132kV (b) 11kV (c) **0.4 kV** (d) 33kV
14. Which one is not situated in Substation?
(a) **Generator** (b) Transformer (c) High Voltage cable .
15. When consumer need personal substation
(a) **Upto 50 kW** (b) Upto 1000 kW (c) Upto 250 kVA.
16. Which one is not used as a wire?
(a) Copper (b) steel (c) Aluminium (d) Aluminium Alloy
17. There are food for a family for 25 days , after 5 days 8 people come and total number of member in family 12 . How many days remaining food will go ?
(a) 6 (b) 8 (c) 10 (d) 12
18. Growth of power section in Bangladesh?
(a) 2% (b) 5% (c) **15%** (d) 10%
19. Highest power demand in Bd?
(a) **12 GW** (b) 9 GW (c) 15 GW
20. Which one is not a protection device ?
(a) (b) **Distribution Box** (c) Relay
21. Correct Spelling – **maintenance** .
22. Antonmy of **Marvellous: Dire ; Terrible: Wonderful.**
23. Tournament:Trophy : : Certificate:Study.
24. 2032 Olympic Bid country?
25. What is Banglapedia – **Bangladesh Asiatic Socceity .**
26. Bangla Academy establish in ? **3rd December,1955**
27. Cancer day? **4th February.**
28. What is the dark night in Bangladesh? **25 March , 1971.**
29. What is the composition of glass? **SiO₂**
30. Chronometer used for?
It is used for measuring time accurately in spite of motion or variation of temperature, humidity, air pressure.
31. What is the intensity of sound? **Decible.**
32. Left the town – (a) **Immediately** (b) Recently (c) Suddenly (d) Tuerriently
33. $11(r-1)=13(s-1)$; $r+s$? **Ans:26**
34. 5 Metric Tons = how many milligrams? **Answer: 5000000 milligrams.**
35. 1 2 3
 1 4 9
 2 ? 12
36. $\log_{10} \frac{10^{48}}{10^{46}} = ?$ (a) **2** (b) 100 (c) 4.60

37. 8 red , 7 blue , 6 black balls are in a box. In random selection probability of Blue ball is
 (a) $\frac{2}{7}$ (b) $\frac{3}{7}$ (c) $\frac{13}{21}$ (d) $\frac{1}{3}$

38. M people buy a gift for D dollars , 3 people , how many cost remaining people should bear ?

(a) $\frac{D}{M-3}$ (b) $\frac{D}{M^2+M}$ (c) $\frac{3D+D^2}{2M}$

39. $x + \frac{1}{x} = 2$; $x^3 + \frac{1}{x^3} = ??$ Ans:2

40. সমাস নির্ণয় করঃ জনৈক – জন যে এক – কর্মধারয় সমাস ।

41. সাহেব এর বহুবচন – সাহেবান/ সাহেবগন/ সাহেব বর্গ/ সাহেব সকল

42. পৃথিবীর সমার্থক শব্দ – অরনী/ অবনী/ পবন

43. সন্ধি বিচ্ছেদ করঃ মহিমা- মহৎ + ইমন

44. নিশীথ রাতে বাজছে বাশী – নিশীথ কি? – বিশেষ্য/ বিশেষণ/ ক্রিয়া

45. বানান গত দিক থেকে দুটি বানান অশুদ্ধ – হাতি/ হাতী, দাদি/দাদী, নারি/ নারী

46. বিশ্বের যা কিছু চির কল্যানকর, অর্ধেক তার করিয়াছে নারী অর্ধেক তার নর?

ক) রবীন্দ্রনাথ খ) নজরুল গ) সুফিয়া কামাল

47. উষ্মবর্ণ কোনগুলো? – ষ, স, হ, শ

48. কবর কবিতাটি কোন কাব্যগ্রন্থের অন্তর্গত?

ক) রাখালী খ) ধানক্ষেত গ) সোজেন বাদিয়ার ঘাট

49. নারী বীরপ্রতীক কত জন? – ২/ ৫/ ৭

50. শান্তি মিশনে সর্বাধিক সেনা কোন দেশের? ভারত।

51. বাংলাদেশ স্ট্রিট কোন দেশে? – লিবিয়া/ জাপান/ সিয়েরা লিওন/ আইভরি কোস্ট

Departmental

1. A wire of diameter 10mm with conductivity 0.5 w/mk is releasing by convection through a medium with transfer co-efficient 50 w/ m²k. Find the critical thickness of insulation. Also find insulation thickness limit to reduce heat transfer by convection.

Solution: Given, $r_1 = \frac{10}{2} = 5$ mm ; $r_{cr} = ?$ and $r_2 = ?$

Critical insulation of thickness, $r_{cr} = \frac{k}{h} = \frac{0.5}{50} = 0.01$ m = 10mm (Answer)

Insulation thickness limit to reduce heat transfer by convection = 10–5=5mm (Answer)

2. In a counter flow heat exchanger cold fluid enters at 30°C and leaves at 260°C, hot fluid enters at 360°C and leaves at 200°C. Find LMTD.

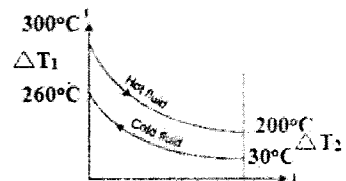
Solution:

Here, $\Delta T_1 = 360 - 260 = 100$;

$\Delta T_2 = 200 - 30 = 170$;

$$\therefore LMTD = \frac{\Delta T_1 - \Delta T_2}{\ln \left(\frac{\Delta T_1}{\Delta T_2} \right)} = \frac{100 - 170}{\ln \left(\frac{100}{170} \right)}$$

= 131.92 °C (Answer)



3. Write down factors of radiation depends between two surface. Write the expression of radiation heat transfer between two parallel surface having temperature T_1 & T_2 where $T_1 > T_2$.

Solution:

- Radiations depends on:
- a) Shape & Size of the surface
 - b) Temperature
 - c) Surface Area
 - d) Surface Properties(Black or Gray)
 - e) Distance between two surface
 - f) Radiation shield (optional)

A_1	A_2
ϵ_1	ϵ_2
T_1	T_2

Let, $A_1 = A_2 = A$; View factor, $F_{1-2} = 1$;

\therefore Expression of radiation heat transfer between two parallel surface,

$$Q = \frac{\sigma A(T_1^4 - T_2^4)}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1}$$

4. A motor (efficiency=90%) deliver power to a pump (efficiency=80%) which delivers 50L/s through a 200m long pipe of dia 150mm having friction factor $f = 0.0051$. Determine Input power of the motor. [Density of the fluid 998 kg/m^3] .

Solution: Overall efficiency = $0.90 \times 0.80 = 0.72$; $A = \pi \frac{D^2}{4} = 0.0176 \text{ m}^2$.

We get, $Q = AV$;

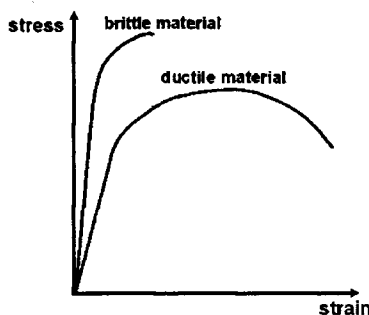
$$\Rightarrow V = \frac{Q}{A} = \frac{50 \times 10^{-3}}{0.0176} = 2.82 \text{ m/s} .$$

$$H = \frac{V^2}{2g} + \frac{fLV^2}{2gD} = 0.405 + 2.75 = 3.16 \text{ m}$$

$$\text{Overall efficiency} = \frac{\gamma QH}{\text{Input Power}}$$

$$\therefore \text{Input power} = \frac{(998 \times 9.81 \times 50 \times 10^{-3} \times 3.16)}{0.72} = 2148.44 \text{ W} = 2.148 \text{ KW (Answer)}$$

5. Show the difference of ductile and brittle material under tensile load by drawing a stress – strain diagram.



6. Two column are clamped at both side. For the first one buckling load 100 N . The diameter of the second one is half of the first one. Find buckling load of the second one if the other parameters are same.

Solution: Given, $P_1 = 100\text{N}$ and $D_2 = \frac{D_1}{2}$

$$\text{We know, } P = \frac{\pi^2 \times EI}{l^2}$$

For column 1, $P_1 = \frac{\pi^2 E \times (\frac{\pi D_1^4}{64})}{l^2} \dots \dots \dots (1)$

For column 2, $P_2 = \frac{\pi^2 E \times (\frac{\pi D_2^4}{64})}{l^2} \dots \dots \dots (2)$

From (2)÷(1) we get, $\frac{P_2}{P_1} = \frac{D_2^4}{D_1^4} = \frac{(\frac{D_1}{2})^4}{D_1^4} = \frac{1}{16}$

$\Rightarrow P_2 = \frac{100}{16} = 6.25 \text{ N (Answer)}$

7. A Kaplan turbine of 1/10 scale model has ahead of 5m. The prototype develops 8500kw at 150 rpm and 10m head. Determine the speed of the model and specific speed of the turbine.

Solution: Hydraulic machines By Quamrul Islam –problem no. 4.3

Given, $\frac{D_m}{D_p} = \frac{1}{10}$, $P_p = 8500 \text{ KW}$, $N_p = 150 \text{ rpm}$, $H_m = 5 \text{ m}$, $H_p = 10 \text{ m}$

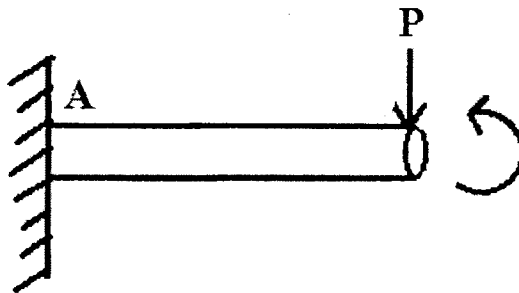
We know, From the similarities of turbines $\frac{H_m}{D_m^2 N_m^2} = \frac{H_p}{D_p^2 N_p^2}$

$\Rightarrow N_m^2 = \frac{D_p^2 N_p^2 H_m}{D_m^2 H_p} = 1125000$

$\Rightarrow N_m = 1060.66 \text{ rpm (Answer)}$

Specific speed of the turbine, $N_s = \frac{N_p \sqrt{P_p}}{H_p^{5/4}} = \frac{150 \times \sqrt{8500}}{10^{5/4}} = 777.67 \text{ rpm (Answer)}$

8. Write down the stresses developed at point A. Draw a 2D element diagram of the loads.



Answer:

2D element diagram



Stresses developed at point A

$$\tau = \frac{T r}{J}$$

$$\sigma_t = \frac{M c}{I}$$

9. The allowable stress of a boiler is 200MPa and the internal pressure is 10MPa.

a) Find the diameter to thickness ratio.

b) Find the longitudinal stress when internal pressure is 10MPa.

Solution:

Given, $\sigma_{\max} = 200 \text{ MPa}$, $P = 10 \text{ MPa}$

a) We know, $\sigma_t = \frac{PD}{2t}$; or, $\frac{D}{t} = \frac{2\sigma_t}{P} = 40$ Answer

b) $\sigma_l = \frac{PD}{4t} = 100 \text{ MPa}$ Answer

10. A 1m long bar of rectangular cross section of 10mm×5mm. A 7000N axial tensile load applied. Find principal stress and maximum shear stress.

Solution:

Given, $A = 10 \times 5 \times 10^{-6} \text{ m}^2$; $P = 7000 \text{ N}$; $L = 1 \text{ m}$.

Given, $\sigma_x = \frac{7000}{10 \times 5 \times 10^{-6}} = 140 \text{ MPa}$, $\sigma_y = 0 \text{ MPa}$, $\tau_{xy} = 0$

We get,

Maximum Normal Stress,

$$\begin{aligned}\sigma_1 &= \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} \\ &= \frac{140 + 0}{2} + \sqrt{\left(\frac{140 - 0}{2}\right)^2 + 0^2} = 140 \text{ MPa (Ans.)}\end{aligned}$$

Minimum Normal Stress,

$$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = \frac{140 + 0}{2} - \sqrt{\left(\frac{140 - 0}{2}\right)^2 + 0^2} = 0 \text{ (Ans.)}$$

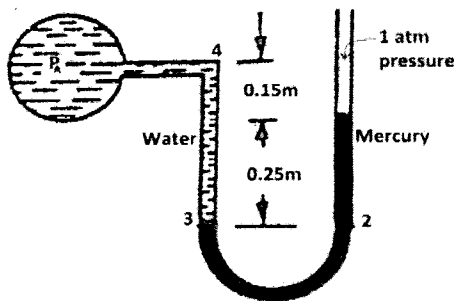
$$\text{Maximum shear stress} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = \sqrt{\left(\frac{140 - 0}{2}\right)^2 + 0} = \frac{140}{2} = 70 \text{ MPa (Ans.)}$$

Dhaka Mass Transit Company Limited (DMTCL)

Post: Assistant Engineer (Mechanical)

Date: 05.01.2019

1. Calculate the pressure P_A .



Solution: At the datum line 3-2, we get,

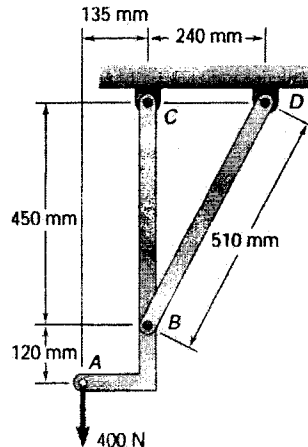
$$P_A + (\rho gh)_{\text{water}} = P_{\text{atmosphere}} + (\rho gh)_{\text{mercury}}$$

$$\Rightarrow P_A + (1000 \times 9.8 \times 0.4)_{\text{water}} = 101325 + (13.6 \times 1000 \times 9.8 \times 0.25)_{\text{mercury}}$$

$$\Rightarrow P_A = 134645 - 3920 = 130725 \text{ Pa}$$

$$\therefore P_A = 130.725 \text{ KPa (abs.) (Answer)}$$

2. Determine the force in member BD.



Solution:

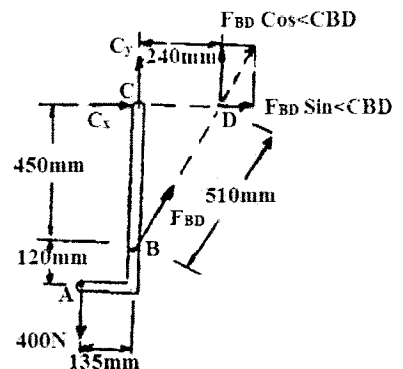
Attaching F_{BD} at D and resolving it into components, we can write

$$+\circlearrowleft \sum M_C = 0$$

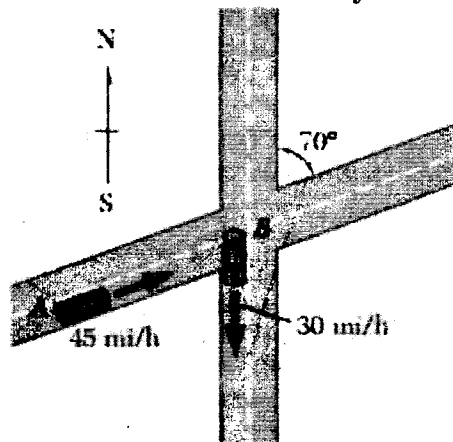
$$\Rightarrow (400\text{N} \times 135\text{mm}) + F_{BD} \cos \angle CBD \times 240\text{mm} = 0$$

$$\Rightarrow (400\text{N} \times 135\text{mm}) + F_{BD} \frac{450}{510} \times 240\text{mm} = 0$$

$$\Rightarrow F_{BD} = 255\text{N} \text{ (Answer)}$$



3. Three seconds after automobile B passes through the intersection shown, automobile A passes through the same intersection. Knowing that the speed of each automobile is constant, determine the relative velocity of B with respect to A.

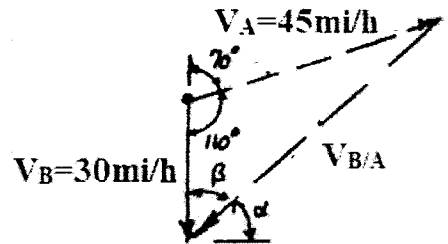


Solution:

According to law of cosines-

$$V_{B/A}^2 = 45^2 + 30^2 - 2 \times 45 \times 30 \times \cos 100^\circ$$

$$\therefore V_{B/A} = 62.04 \text{ mi/hr (Ans.)}$$



4. A centrifugal pump delivers 30l/s of water at a height of 26m. A 3-phase, AC current supply to the motor voltage and current are 400V and 17A respectively. Determine the efficiency of the pump considering the power factor value is 1.

Solution:

$$\text{We get, Power input} = \sqrt{3} V I \cos \theta = \sqrt{3} \times 400 \times 17 \times 1 = 11777.9455$$

$$\text{Power Output} = \rho g H Q = 1000 \times 9.81 \times 26 \times 30 \times 10^{-3} = 7651.8$$

$$\therefore \text{Efficiency} = \frac{\text{Power Output}}{\text{Power Input}} = \frac{\rho g H Q}{\sqrt{3} V I \cos \theta} = \frac{7651.8}{11777.9455} = 0.6496$$

$$\therefore \text{Efficiency} = 64.96\% \text{ (Answer)}$$

5. Both end-hinged column 1m Length, 20×30 mm. Find flowing parameters:

Parameters	Values
Second moment of inertia	$I = \frac{bh^3}{12} = \frac{20 \times 30^3}{12} = 45000 \text{ mm}^4 \text{ (Answer)}$
Radius of gyration	$k = \sqrt{\frac{I}{A}} = \sqrt{\frac{45000}{20 \times 30}} = 8.66 \text{ mm (Answer)}$
Slenderness ratio	$\frac{L}{K} = \frac{1000}{8.66} = 115.47 \text{ (Answer)}$
Critical buckling load	$P_{cr} = \frac{N \pi^2 E L}{I} = \frac{1 \times \pi^2 \times 200 \times 10^9 \times 45000 \times 10^{-9}}{1000} = 88826.855 \text{ N (Answer)}$

6. Draw the schematic diagram of following beam:

Types of beam	Diagram
Simply supported beam	
Overhanging beam	
Cantilever beam	
Fixed beam	
Cantilever, simply supported beam	

7. A circular test bar specimen of diameter of 80 mm & length 600 mm is subjected to elongation test. Test result shows:— gauge length 200 mm, Yield load 225KN,

braking load 242 KN, final length after elongation 249 mm. Find the braking strength and percent of elongation?

Solution: Given that, $d = 80 \text{ mm}$, $L = 600 \text{ mm}$, Gauge length, $L_g = 200 \text{ mm}$, Braking load = 242 KN, Final length after elongation, $L_e = 249 \text{ mm}$

We get, Breaking strength = $\frac{\text{Breaking load}}{\text{Cross sectional area}} = \frac{242 \times 1000}{\frac{\pi}{4} \times (0.08)^2} = 48.14 \text{ MPa (Answer)}$

Again, Percentage of elongation = $\frac{L_e - L_g}{L_g} = \frac{249 - 200}{200} = 24.5\% \text{ (Answer)}$

8. Draw T-S diagram for the following system:

[May be it was combined cycle Gas-Steam Power Plant/ Rankine Cycle with FWH.]

9. A power plant has peak load 75 MW, having maximum connecting load 45, 30, 20 & 10 MW. If load fraction is 0.6 then find: (i) Average load (ii) Demand factor.

Solution: Given,

Maximum demand = 75 MW

Connecting load = $(45 + 30 + 20 + 10) \text{ MW} = 105 \text{ MW}$

Load factor = 0.6

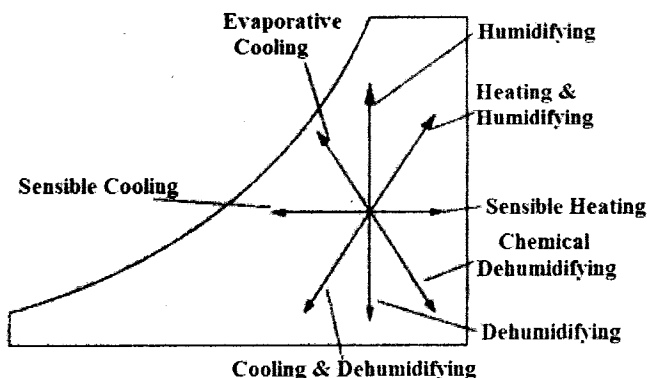
We know,

$$\begin{aligned} \text{(i) Load factor} &= \frac{\text{Average Load}}{\text{Maximum Demand}} \\ \Rightarrow 0.6 &= \frac{\text{Average Load}}{75} \\ \Rightarrow \text{Average load} &= 45 \text{ MW (Answer)} \end{aligned}$$

$$\begin{aligned} \text{(ii) Demand factor} &= \frac{\text{Maximum Demand}}{\text{Connecting load}} \\ &= \frac{75}{105} = 0.715 \text{ (Answer)} \end{aligned}$$

10. Show different process on a psychrometric chart

- (i) Heating and humidification**
- (ii) Sensible heating**
- (iii) Chemical dehumidification**
- (iv) Evaporative cooling**

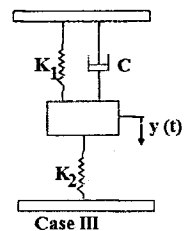
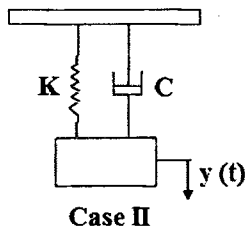
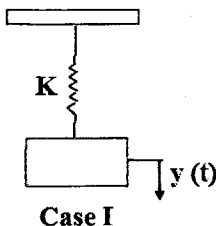


11. Write down the matching tool for making following specimens:

	Tool
Mechanism of circular specimen for tensile test	Lathe Machine
Cylindrical taper specimen	Lathe Machine
Rectangular (size 2" 3") specimen for plane surface	Shaper Machine
Hole in a circular section	Drill Press
Shaper specimen for impact test	Shaper Machine

12. The following equation is given for the following cases:

$$\frac{d^2y}{dt^2} + a \frac{dy}{dt} + by = 0$$



Fill in the box:

Constant	Case-I	Case-II	Case-III
a	0	$\frac{C}{m}$	$\frac{C}{m}$
b	$\frac{K}{m}$	$\frac{K}{m}$	$\frac{K_1 + K_2}{m}$

13. The temperature of the salt bath is 40°C, the initial temperature of the ball is 900°C. For hardening purpose, the ball is immersed in salt bath and reduced the temperature of the ball is 50°C. How much does take time to come at this temperature.(Time constant is 10 S⁻¹)**Solution:****We know,**

$$\frac{T_t - T_\alpha}{T_i - T_\alpha} = e^{-\frac{hA}{\rho cv} \times t}$$

$$\Rightarrow \frac{50 - 40}{900 - 40} = e^{-\frac{1}{10} \times t}$$

$$\Rightarrow \frac{1}{86} = e^{-\frac{1}{10} \times t}$$

$$\Rightarrow \ln\left(\frac{1}{86}\right) = -\frac{t}{10} \ln e$$

$$\Rightarrow -4.45 = -\frac{t}{10}$$

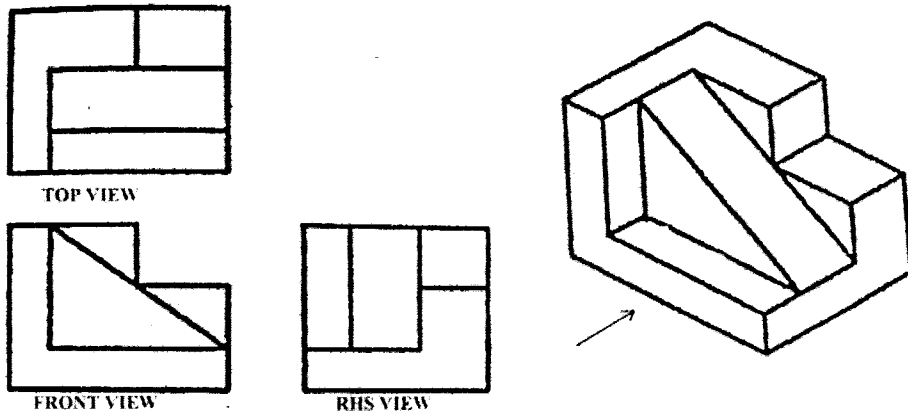
$$\therefore t = 44.54 \text{ sec (Answer)}$$

Given,

$$\text{Time constant} = \frac{\rho cv}{hA} = 10 \text{ s}^{-1}$$

14. Average heat transfer and local heat transfer related math.

15. Draw top, front and R.H.S. view from the following isometric view.



B-R Powergen Ltd.

Post: Assistant Engineer (Mechanical)

Time 02.30PM to 04.00PM

Date: 04.05.2019

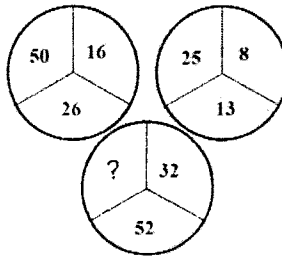
Exam Hall: MIST

Analytical: $10 \times 2 = 20$; GK+Bangla+English=30; Written= 50

Analytical

- If x and y are prime numbers, which of the following cannot be the sum of x and y ?
(a) 5 (b) 24 (c) 23 (d) 26
- If numerator and denominator is increased by adding same number, then-
(a) Fraction will be same (b) Fraction will increase (c) Fraction will decrease
(d) None of this
- Lion: Pride::Wolf: ____?
(a) Herd (b) Flock (c) Pack (d) Gaggle
- A man from point A starts his journey goes 1 km north. He turns 2 km east, then 3 km south, from that point he goes 4km west, finally 2 km north and reaches point B. Minimum distance between A and B.
(a) 4Km (b) 1Km (c) 2Km (d) 3Km
- If each side of a square is increased by 3cm, its area is increased by 33cm^2 . Find the length of a side of the original square.
(a) 3 (b) 4 (c) 5 (d) 6
- By weight, liquid A makes up 8 percent of solution R and 18 percent of solution S. If 3 grams of solution R mixed with 7 grams of solution S, then liquid A accounts for what percent of the weight of the solution?
(a) 8.2% (b) 7.3% (c) 9.4% (d) 15%

7. Radius of a circle is 3cm and center angle 0.8 rad. What is the arc length?
 (a) 3.75cm (b) 2.4cm (c) 0.3cm (d) 2.75cm
8. A man is standing in front of a painting man. The man says, Brothers and sisters I have none and the man's father is my father's son. How the related the man to the painting man.
 (a) His Son (b) His Father (c) His Nephew (d) His Uncle
9. What number will be for question mark?



- (a) 168 (b) 120 (c) 64 (d) 100
10. From a point P on a level ground, the angle of elevation of the top tower is 30° . If the tower is 100 m high, the distance of point P from the foot of the tower is:
 (a) 149 m (b) 156 m (c) 173 m (d) 200 m

GK+Bangla+English

11. The highest waterfall of the world is _____.
 (a) Niagara Falls (b) Boyoma Falls (c) Salto Angel Falls (d) Khone Falls
12. Which is the correct spelling?
 (a) Acknoldgement (b) Acknowldgment (c) Acknolgement (d) Acknowledgement
13. Which country is the founder of BRI?
 (a) USA (b) India (c) Brazil (d) China
14. Who is the designer of National memorial?
 (a) Mrinal Kanti (B) Nitun Kundu (c) Hamidur Rahman (d) Syed Mainul Hossain
15. BCIM consists of _____.
 (a) Bangladesh, China, India, Myanmar (b) Brazil, China, India, Myanmar
 (c) Bangladesh, China, India, Maldives (d) Brazil, China, Indonesia, Myanmar
16. Which materials is used in 2B pencil?
 (a) Lead (b) carbon (c) graphite
17. The lowest point, on land, in the world is
 (a) Death valley (b) Caspian sea (c) Dead sea (d) Lake Eyre
18. Capital city of Kazakhstan is ____
 (a) Astana (b) Astin (c) Nursultan (d) Kabul
19. The largest organ of the human body is_?
 (a) Liver (b) Skin (c) Brain (d) Heart

20. Largest powerplant of Bangladesh ____.

(a) Rampal (b) Ashuganj (c) Ghorashal (d) Meghnaghat

21. শেষের কবিতা কি ধরনের রচনা?

(a) কবিতা (b) উপন্যাস (c) কাব্যধর্মী উপন্যাস (d) কাব্যগ্রন্থ

22. বাংলা ভাষায় মৌলিক স্বরধ্বনির সংখ্যা কত?

(a) ৭টি (b) ১১টি (c) ৯টি (d) ১৩টি

23. Who is the designer of Bangladesh National Parliament?

(a) Louis I Khan

24. Which is not renewable?

(a) solar (b) wind (c) tide (d) nuclear

25. Who is the First Bangladeshi woman to conquer Everest?

(a) Nishat Mazumder

26. Who has invented the genome of jute- Maqsudul Alam.

27. Which country first recognize Bangladesh as independent?

(a) India (b) Bhutan

28. Color of Pb_3O_4 is - Red

29. Which district doesn't related to mangrove forests??

(a) Khulna (b) Jessore (c) Bagerhat (d) Satkhira

30. Earth quake waves travel fastest in

(a) Soil (b) Molten rock (c) Water (d) Flexible rock

31. Which sentence is correct-

(a) I want my salary immediately. (b) Immediately I want my salary.

32. The cat jumped ____ wall.

(a) over (b) on (c) through

33. আব্দুল্লাহ আবু সায়ীদ স্যার কোনটির সাথে জড়িত না?

(a) বিশ্ব সাহিত্য কেন্দ্র (b) বাংলা একাডেমি (c) ভ্রাম্যমাণ লাইব্রেরী (d) সাইন্স ফিকশন

34. One horsepower is equal to

(a) 102 watts (b) 75 watts (c) 550 watts (d) 746 watts

35. Joule is the unit of-

(a) Heat (b) Energy (c) Power

36. Who did announce the first budget of Bangladesh? – Tajuddin Ahmed

37. Which is the brightest planet in the solar system seen from earth? - Venus

38-40 [Cannot recall]

Written

41. Write a short note on B-R powergen Limited including the following

(a) Vision and mission of B-R Powergen

(b) How many power plants do B-R Powergen have.

(c) When B-R Powergen established.

Answer: B-R Powergen Ltd. was established on 2010 as a public limited company by equal shares of BPDB & RPCL under power division, Ministry of power, Energy and Mineral Resources. **Vision:** To accelerate socio-economic development of the country through reliable power generation. **Mission:** To implement power plant project as per Government's plan to meet up the country's growing demand of electricity.

There are three plants under B-R powergen Ltd.: Kodda (150MW); Mirsarai (150MW) and Sreepur (150MW).

42. Write a paragraph on "Importance of Presentation Skill."

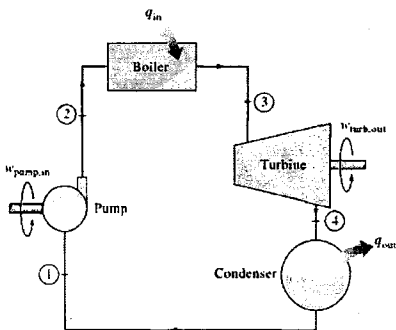
Answer: Presentation skill is an important aspect of life. It reflects the mirror image of a presenter's true self. It reflects the behavior, attitude of a person. A Good presenter can be a good leader. Presentation is an important skill for people from different walks of life. A teacher with good presentation skill can motivate his/her students properly. An Army General who is a good presenter can motivate and guide his soldiers properly can lead the nation to victory in the state of war. A doctor with good presentation skill can motivate his patients and treat both physically and psychologically. A sales person with good presentation skill can have good psychological impact on potential buyers. So the importance of presentation skill in socio- psychological aspects cannot be denied. Presentation is not only a skill but also an education.

43. নির্মাণাধীন পদ্মা সেতু সম্পর্কে ছয় লাইনের একটি অনুচ্ছেদ লিখুন।

পদ্মা সেতু বাংলাদেশের পদ্মা নদীর উপর নির্মাণাধীন একটি বহুমুখী সড়ক ও রেল সেতু। এর মাধ্যমে লৌহজং, মুন্সীগঞ্জের সাথে শরীয়তপুর ও মাদারীপুর যুক্ত হবে, ফলে দেশের দক্ষিণ-পশ্চিম অংশের সাথে উত্তর-পূর্ব অংশের সংযোগ ঘটবে। বাংলাদেশের মত উন্নয়নশীল দেশের জন্য পদ্মা সেতু হতে যাচ্ছে এর ইতিহাসের একটি সবচেয়ে বড় চ্যালেঞ্জিং নির্মাণ প্রকল্প। দুই স্তর বিশিষ্ট স্টিল ও কংক্রিট নির্মিত ট্রাস ব্রিজটির (truss bridge) ওপরের স্তরে থাকবে চার লেনের সড়ক পথ এবং নিচের স্তরটিতে থাকবে একটি একক রেলপথ। পদ্মা-ব্রহ্মপুত্র-মেঘনা নদীর আববাহিকায় ১৫০মিটার দৈর্ঘ্যের ৪১টি স্পান বসবে, ৬,১৫০ মিটার দৈর্ঘ্য এবং ১৮.১০ মিটার প্রস্থ পরিকল্পনায় নির্মিত হচ্ছে দেশটির সবচে বড় সেতু। প্রকল্পটি তিনটি জেলাকে অন্তর্ভুক্ত করবে- মুন্সীগঞ্জ (মাওয়া পয়েন্ট / উত্তর পাড়), শরীয়তপুর এবং মাদারীপুর (জঞ্জিরা / দক্ষিণ পাড়)।

44. Draw the schematic diagram of steam power plant. Why condenser is necessary for steam power plant.

Answer:

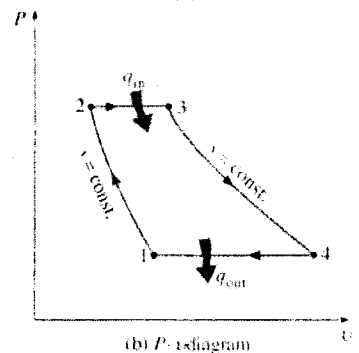
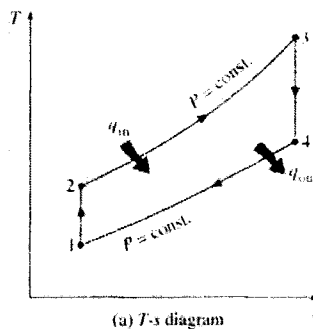
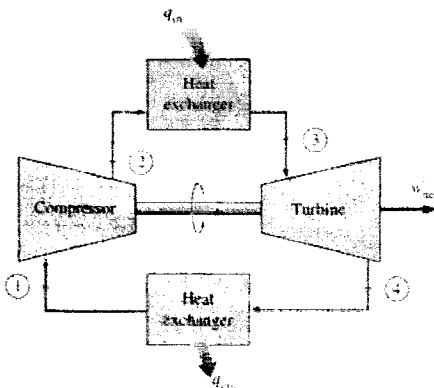


(1) The first objective is to create a low back pressure (vacuum) at the turbine exhaust so as to obtain the maximum possible energy conversion from the high pressure and high temperature steam and thus to increase the efficiency of the power plant.

(2) The secondary objective is to condense the exhaust steam coming from the turbine and therefore recover the high-quality feed water for the reuse in the cycle of operation.

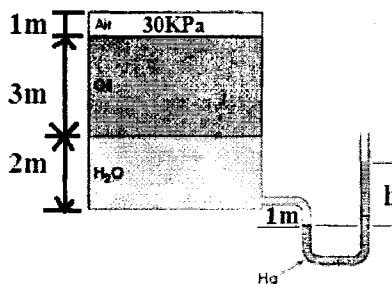
45. Draw the schematic diagram of Brayton cycle power plant with the working procedures of a gas turbine. Draw the P-V and T-S diagram.

Answer: Closed cycle gas turbine:



Atmospheric air flows through the compressor that brings it to higher pressure. Energy is then added by spraying fuel into the air and igniting it so the combustion generates a high-temperature flow. This high-temperature high-pressure gas enters a turbine, where it expands down to the exhaust pressure, producing a shaft work output in the process. The turbine shaft work is used to drive the compressor.

46. If the specific gravity of oil is 0.85, find the h.



Solution: We get,

$$30 + 3 \times 0.85 \times 9.81 + 2 \times 9.81 + 1 \times 9.81 = h \times 9.81 \times 13.6$$

$$\Rightarrow h = 0.635 \text{ m of Hg (Answer)}$$

47. A Centrifugal pump is required to pump water to an open water tank situated 4km away from the location of the pump through a pipe of diameter 0.2m having Darcy's friction factor of 0.01. The average speed of water in the pipe is 2 m/s. If it is maintain a constant head of 5 m in the tank, neglecting other minor losses, find the absolute discharge pressure at the pump exit.

Solution:

$$\text{Here, } H=5\text{m; } V=2\text{m/s; } f=0.01; d=0.20\text{m; } L=4000\text{m}$$

$$\text{We get, } P_{\text{abs}} = H\rho g + H_f\rho g + P_{\text{atm}}$$

$$\Rightarrow P_{\text{abs}} = H\rho g + \frac{fLv^2}{2gd}\rho g + P_{\text{atm}}$$

$$\Rightarrow P_{\text{abs}} = (5 \times 1000 \times 9.81) + \left(\frac{0.01 \times 4000 \times 2^2}{2 \times 9.81 \times 0.2} \times 1000 \times 9.81 \right) + 101325$$

$$\therefore P_{\text{abs}} = 550375 \text{ Pa} = 550.375 \text{ KPa (Answer)}$$

48. Air enters at 200°C nozzle with velocity 100m/s, Air exits with velocity 200m/s. Find the exit temperature. C_p for air is 1.045KJ/Kg.

Solution:

We get,

$$\frac{v_2^2}{2} - \frac{v_1^2}{2} = C_p(T_1 - T_2)$$

$$\Rightarrow \frac{200^2}{2} - \frac{100^2}{2} = C_p(200 - T_2)$$

$$\Rightarrow 15000 = 1045(200 - T_2)$$

$$\Rightarrow 14.35 = 200 - T_2$$

$$\Rightarrow T_2 = 200 - 14.35 = 185.65^\circ\text{C (Answer)}$$

49. Increasing volumetric efficiency of IC engine is a major task of mechanical engineers. Write the five process of increasing the volumetric efficiency.

Answer:

(a) Keep the intake mixture cool: By ducting intake air from outside of the engine compartment and keeping the fuel cool, the intake mixture can be kept cooler. The cooler the mixture is, the higher the volumetric efficiency will be. This is because a cool mixture is denser or more tightly packed.

(b) Modify the intake passages: Any changes to the intake passages that make it easier for the mixture to flow through will cause an increase in volumetric efficiency. Other changes include reshaping ports to smooth out bends, reshaping the back of the valve heads, or polishing the inside of the ports.

(c) By altering the time (variable valve timing) that the valves open or how far they open, volumetric efficiency can be improved.

(d) By supercharging and turbocharging:

(e) To use larger valves or multiple valves. Larger valves increase flow but weigh more. Multi-valve engines combine two or more smaller valves with areas greater than a single, large valve while having less weight. Carefully streamlining the ports increases flow capability. This is referred to as Porting and is done with the aid of an air flow bench for testing.

50. A vapor compressor refrigerant enthalpy (Kj/kg) given as follows:

Inlet of condenser enthalpy 283Kj/Kg

Exit of condenser 116Kj/Kg

Exit of Evaporator 232Kj/Kg

Find the COP and draw p-h diagram.

Solution:

In a vapor compression refrigeration cycle inlet condenser enthalpy is 283 KJ/Kg, exit condenser enthalpy is 116 KJ/Kg, exit evaporator enthalpy is 232 KJ/Kg, Find COP.

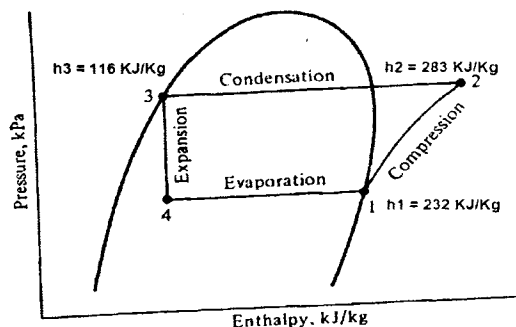
Answer:

We have,

$$\text{COP} = \frac{\text{Cooling effect}}{\text{compressor work}}$$

$$= \frac{h_1 - h_4}{h_2 - h_1} = \frac{232 - 116}{283 - 232}$$

$$= \frac{116}{51} = 2.2745$$



According to the P-h figures,

h_2 = enthalpy at inlet of condenser = 283 KJ/Kg

$h_3 = h_4$ = enthalpy at exit of condenser = 116 KJ/Kg

h_1 = enthalpy at the inlet of compressor = 232 KJ/Kg

51. A reversible Carnot cycle temperature range is between 305°K and 260°k. Find the COP/Efficiency of (i) Refrigerator and (ii) heat engine.

Solution:

(i) $\text{COP of Refrigerator} = \frac{260}{305 - 260} = 5.78 \text{ (Ans.)}$

(ii) $\text{Efficiency/COP of Heat Engine} = \frac{305 - 260}{305} = 0.1475 = 14.75\% \text{ (Ans.)}$

Bangladesh Steel & Engineering Corporation

বিসয়:সহকারী প্রকৌশলী(তড়িৎ/পুর/যন্ত্র) পদে জনবল নিয়োগের পরীক্ষা

পূর্ণমান: ৭৫

সময়: ১ঘন্টা ৩০ মিনিট

(১) সঠিক উত্তর লিখুন।

(i) সন্ধির প্রধান সুবিধা কী? (a) উচ্চারণের সুবিধা (b) লেখার সুবিধা (c) শোনার সুবিধা (d) পড়ার সুবিধা

(ii) মৃতের মত অবস্থা যার - (a) মুমূর্ষু (b) মুমূর্ষু (c) মুমূর্ষ (d) মুমূর্ষু

(iii) Choose the correct spelling-

(a) milenium (b) millenium (c) millennium (d) millenniumn

(iv) My result did not come --- to my expectation

(a) Of (b) up (c) across (d) off

(v) এক ব্যক্তি প্রকৃত দরের ১০% কম দামে একটি দ্রব্য কিনে প্রকৃত দরের ১০% বেশি দামে বিক্রি করল। তার লাভ বা ক্ষতির শতকরা হার-

(a) ২০% এর বেশি লাভ (b) ২০% লাভ (c) ২০% এর কম লাভ (d) লাভ ক্ষতি কিছুই হয়নি

(vi) নিব্বুম দ্বীপ কোথায় অবস্থিত? (a) কুতুবদিয়া (b) হাতিয়া (c) মহেশখালি (d) সন্দ্বীপ

(vii) শেখ মুজিবুর রহমান 'বঙ্গবন্ধু' উপাধি লাভ করেন-

(a) ১৯৬৯ (b) ১৯৭০ (c) ১৯৭১ (d) ১৯৭২

(viii) স্টেপ-আপ ট্রান্সফরমার ব্যবহার করা হয়-

(a) ট্রান্সমিশন লাইনের শুরুতে (b) ট্রান্সমিশন লাইনের শেষ প্রান্তে (c) ডিস্ট্রিবিউশন সাব স্টেশনে (d)

ডিস্ট্রিবিউটর লাইনে

(ix) এক খণ্ড মাটির void এর volume আর total volume এর অনুপাতকে কি বলে?

(a) Void ratio (b) porosity (c) Water content (d) Degree of saturation

(x) আগামী বিশ্বকাপ ফুটবল খেলা কবে কোথায় অনুষ্ঠিত হবে?

(a) ২০২২ সালে কাতারে (b) ২০২৪ সালে কুয়েতে (c) ২০২০ সালে দক্ষিণ আফ্রিকায় (d) ২০২২ মিশরে

(২) 'আমার ভাইয়ের রক্তে রাঙ্গানো একুশে ফেব্রুয়ারী'-গানটির গীতিকার কে?

উঃ আবদুল গাফফার চৌধুরী

(৩) 'চিনির পুতুল' বাগধারার অর্থসহ বাক্য গঠন কর।

উঃ পরিশ্রমকাতর। কে কোন কাজই করতে চায়না। যেন চিনির পুতুল।

(৪) 'যে সম্পত্তি হস্তান্তর করা যায় না'-তাকে কি বলে?

(৫) বাংলায় অনুবাদ কর।

The state language movement in 1952 is mainly well known as language movement in Bangladesh. Of course the period between 1948 to 1952 is specially significant for language movement. Anyway there is a long history about the language debate in this country. This pain and success of the rise of Bengali nation is involved with this. It is important to search its root.

উঃ ১৯৫২ সালের আঞ্চলিক ভাষা আন্দোলন প্রধানত বাংলাদেশের ভাষা আন্দোলন নামে সুপরিচিত। অবশ্যই ১৯৪৮ থেকে ১৯৫২ পর্যন্ত সময়কাল ভাষা আন্দোলনের জন্য বিশেষভাবে উল্লেখযোগ্য। এই দেশে ভাষা নিয়ে বিতর্কের পিছনে দীর্ঘ ইতিহাস আছে। বাঙালি জাতির উত্থানের এই বেদনা এবং সাফল্য এই সাথে জড়িত। এটির মূলটি অনুসন্ধান করা গুরুত্বপূর্ণ।

(6) Translate in English.

যে সমস্ত গুণ থাকলে মানুষ যথার্থ বড় হতে পারে সত্যবাদিতা তার অন্যতম। সত্য কথা বলতে না শিখলে কখনও অপরের বিশ্বাসভাজন হওয়া যায় না। যাকে কেউ বিশ্বাস করে না সে কখনও প্রতিষ্ঠা লাভ করতে পারে না। মিথ্যা কথা বলে হয়ত দুই-একবার কার্যসিদ্ধি হতে পারে কিন্তু সে রকম কার্যসিদ্ধি থেকে কোন স্থায়ী সুফল ফলে না। একদিন না একদিন তা প্রকাশ হয়ে পড়বেই।

Ans: Truthfulness is one of those virtues which make people great. If one does not learn to speak truth, then he can never be trusted. He can never be established by anyone who does not believe. You can be benefited once or twice by telling lie. There is no permanent benefit from such a performance. It will be exposed one day or not.

(7) Which of the following words is not in the plural form?

(a) Data (b) radius (c) Plena (d) curricula

(8) Which of the following words is not an adjective?

(a) humble (b) humane (c) humid (d) humor

(৯) একটি শোনার গয়নার ওজন ৩২ গ্রাম। এতে সোনা ও তামার অনুপাত

৩ঃ১। এতে কি পরিমাণ সোনা মিশালে অনুপাত ৪ঃ১ হবে?

সমাধানঃ সোনার পরিমাণ = $\frac{3}{8} \times 32 = 12$ গ্রাম তামার পরিমাণ = $\frac{1}{8} \times 32 = 4$ গ্রাম

সোনার অতিরিক্ত পরিমাণ = x গ্রাম, $\frac{x+28}{8} = \frac{4}{1}$ বা, $x = 4$ গ্রাম (উত্তর)

(১০) বৃত্তের একই চাপের উপর দণ্ডায়মান কেন্দ্রস্থ কোন পরিধি কত কত গুণ?

উঃ দ্বিগুণ

(১১) ডেস্ক জরের বাহক মশার নাম কি? উঃ এডিস মশা

(১২) মাধ্যাকর্ষণ শক্তি কে আবিষ্কার করেছেন? উঃ নিউটন

(১৩) বাংলাদেশের একমাত্র পানি বিদ্যুৎ কেন্দ্রটি কোথায় অবস্থিত? উঃ চট্টগ্রাম

(১৪) বিশ্বকাপ ফুটবল, ২০১৮ এ চ্যাম্পিয়ান হয় কোন দেশ? উঃ ফ্রান্স

(১৫) পৃথিবীর কোন দেশের মানুষ সংবাদপত্র সবচেয়ে বেশি পড়ে? উঃ

সহকারি প্রকৌশলী (যান্ত্রিক) পরীক্ষার জন্য (১৬-২০)

(১৬) বয়লার কি? সেফটি ভালভের কাজ কি?

(১৭) থার্মোডাইনামিক্স বলতে কি বুঝ? এর ৫ টি প্রয়োগক্ষেত্র লিখ।

(১৮) Shock Absorber এর কাজ কি? সাসপেনশন পদ্ধতি কত প্রকার ও কি কি?

(১৯) Propeller Shaft কি? Universal Joint এর কাজ কি?

(২০) S.I ইঞ্জিন কি? ৪ (চার) স্ট্রোক ইঞ্জিনের স্ট্রোকগুলো কি কি?

২১-৩০ পর্যন্ত প্রশ্নগুলো ছিল তড়িৎ ও পুর কৌশলীদের জন্য।

সকল পরীক্ষার্থীর জন্য আবশ্যিক

(৩১) CAD-CAM এর পূর্ণরূপ কি? কোথায় ব্যবহারযোগ্য ?

CAM- Computer-Aided Manufacturing. CAD-Computer-Aided Design.

CAM মেশিন টুলস নিয়ন্ত্রনে ও ওয়ার্কপিসের উতপাদনে সফটওয়্যারের ব্যবহারকে বুঝায়।

কম্পিউটার-এডেড ডিজাইন (সিএডি) একটি কম্পিউটার প্রযুক্তি যা একটি পণ্য ডিজাইন করে এবং নকশাটির প্রক্রিয়া নথিভুক্ত করে।

(৩২) UPS এর পূর্ণরূপ কি? এর কাজ কি ?

উঃ UPS- Uninterruptible Power Supply

ইনপুট পাওয়ার সোর্স বা বিদ্যুৎ সরবরাহ ব্যর্থ হলে এই বৈদ্যুতিক যন্ত্র জরুরি শক্তি সরবরাহ করে।

(৩৩) MS-Word বলতে কি বুঝায়? এটি কি ধরনের সফটওয়্যার?

উঃ মাইক্রোসফ্ট ওয়ার্ড বা এমএস ওয়ার্ড একটি গ্রাফিকাল ওয়ার্ড প্রসেসিং প্রোগ্রাম যা ব্যবহারকারীরা টাইপ করতে পারেন। এটা কম্পিউটার কোম্পানী মাইক্রোসফ্ট দ্বারা তৈরি করা হয়। এর উদ্দেশ্য ব্যবহারকারীদের নথি টাইপ এবং সংরক্ষণ করা।

(৩৪) Intranet বলতে কি বুঝায়? ১টি উদাহরন দাও।

উঃ ইন্ট্রানেট একটি নেটওয়ার্ক যেখানে কর্মচারীরা সামগ্রী তৈরি করতে, যোগাযোগ করতে, সহযোগিতা করতে ও কোম্পানির প্রয়োজনে করতে পারে। যেমনঃ বাংলাদেশের সরকারি সাইটগুলা। (bsec.gov.bd)

(৩৫) LAN, WAN এর পূর্ণরূপ কি?

উঃ LAN- Local Area Network WAN-Wide area Network

উত্তরঃ (১) (i) a;(ii) d; (iii) c;(iv) d;(v)a;(vi) b; (vii)a; (viii)a; (xi) b;(x)a (7) b; (8) d.

NESCO Recruitment Examination 2018
Name of the Post : Assistant Engineer (EEE/ME/CE)
Exam Hall: RUET

SET C

Full Marks : 50

Time : 40 mins.

১। বাংলা সাহিত্যে সনেট রচনার প্রবর্তক কে?
 (A) রবীন্দ্রনাথ ঠাকুর (B) মাইকেল মধুসূদন দত্ত
 (C) দেবেন্দ্রনাথ ঠাকুর (D) মোহিতলাল মজুমদার

২. উন্নীত শব্দের বীপরীতার্থক শব্দ কি?
 (A) বিনীত (B) অবনমিত
 (C) অবনীত (D) অধোগতি

৩. নিচের কোন শব্দটি প্রত্যয় যোগে গঠিত হয় নি?
 (A) সভাসদ (B) ফলবান
 (C) শুভেচ্ছা (D) তথ্য

৪. নিচের কোনটি দেশী শব্দ?
 (A) পিতা (B) দুধ
 (C) নারিকেল (D) সূর্য

৫. 'তুমি আসবে বলে হে স্বাধীনতা' কবিতাটি কার লেখা?
 (A) সৈয়দ শামসুল হক (B) শামসুর রহমান
 (C) শওকত ওসমান (D) নির্মলেন্দু গুণ

৬. সমার্থক শব্দ নয় এমন শব্দগুচ্ছ চয়ন কর?
 (A) কুকুর, কুকুট, সারমেয় (B) জায়া, ভার্যা, অর্ধাংগিনী
 (C) অরবিন্দ, কুবলায়, কোকনাদ (D) মার্গ, সরনি, সড়ক

৭. 'মোদের গরব মোদের আশা আ'মরি বাংলা ভাষা' গানটি কার লেখা?
 (A) রবীন্দ্রনাথ ঠাকুর (B) আব্দুল গাফফার চৌধুরী
 (C) অতুল প্রসাদ সেন (D) কামিনী রায়

৮. বিষাদসিন্ধু এর সমাস কোনটি?
 (A) উপমান কর্মধারয় (B) তৎপুরুষ
 (C) রূপক কর্মধারয় (D) অব্যয়ীভাব

৯. 'এ যে আমার চেনা লোক' বাক্যে 'চেনা' কোন পদ?

১৬. Identify the correct sentence
 (a) Yesterday, he has gone home.
 (b) Yesterday, he went home.
 (c) Yesterday, he had gone home.
 (d) Yesterday, he went to home.

১৭. Identify the analogy word pair –
 Electricity: wire
 (a) car: highway (b) fluid: pipe
 (c) river: bank (d) light: bulb

১৮. Which one is correct
 (a) Did you finish the work yet?
 (b) Did you finished the work yet?
 (c) Have you been finished the work yet?
 (d) Have you finished the work yet?

১৯. What is the antonym of 'Impervious'?
 (a) tolerable (b) convince
 (c) penetrable (d) hidden

২০. In a revolutionary development in technology, Some manufactures now make biodegradable Forms of plastic, some plastic trash bags for example , gradually----- when exposed to sunlight.

(a) harden (b) stagnate
 (c) decompose (d) inflate

২১. Choose the correct spelling:
 (a) Bureaucarcy (b) Bourocracy
 (c) Burocracy (d) Bureocracy

২২. Which one Is singular number?
 (a) Criteria (b) Agenda
 (c) Data (d) Index

২৩. 'Through thick and thin' means?
 (a) under all conditios (b) to make thick and thin
 (c) not clear in understanding (d) of great density

২৪. We look forward --- a response from you.
 (a) to receiving (b) to receive

(A) বিশেষ্য (B) বিশেষণ

(C) অব্যয় (D) ক্রিয়া

১০. 'যদি লোভ পরিত্যাগ কর, তবে সুখে থাকবে' - কোন ধরনের বাক্য?

(A) জটিল বাক্য (B) সরল বাক্য

(C) যৌগিক বাক্য (D) মিশ্র বাক্য

১১. নিচের কোন শব্দজোড়া অশুদ্ধ?

(A) শুষ্ক - রুক্ষ (B) সুবহ - দুর্বহ

(C) ক্রয়-বিক্রয় (D) স্বতন্ত্র- পরতন্ত্র

১২. তালব্য বর্ণ সমূহ কোনটি?

(A) প ফ ব ভ ম (B) ত থ দ ধ ন

(C) ট ঠ ড ঢ ণ (D) চ ছ জ ঝ ঞ

১৩. He insisted ----- there.

(a) On my going (b) is to go

(c) To go (d) for going

১৪. "Prior to" means

(a) After (b) before

(c) Immediately (d) during the period of

১৫. Which is the noun of "beautiful"?

(a) Beauty

(b) Beautify

(c) Beauteous

(d) Beautifully

২৭. There are twice as many girls as boys in an English class. If 30% of the girls and 45% of the boys have already handed in their assignment in due time. What percentage of the students have not yet handed in their assignments?

(a) 45%

(b) 50%

(c) 70%

(d) 65%

২৮. $\log_3\left(\frac{1}{9}\right) = ?$

(a) 2

(b) 3

(c) -3

(d) -2

২৯. একটি বর্গের এক পাশ ২০% বৃদ্ধি করা হলো। অন্য পাশ শতকরা কত কমাতে

(c) in receiving

(d) for receiving

২৫. In a diagram below $b:a = 7:2$. What is $(b-a)$?(a) 20° (b) 70° (c) 100° (d) 120° ২৬. $x^2 - 8x - 8y + 16 + y^2$ এর সাথে কত যোগ করলে যোগফল পূর্ণবর্গ হবে?(A) $2xy$ (B) $4xy$ (C) $-2xy$ (D) $-4xy$ ৩৭. If $\left(\frac{1}{2}x\right)$ years ago, Masud was 12 and $\left(\frac{1}{2}x\right)$ years from now he will be $2x$ years old. How old will he be $3x$ years from now?

(a) 18

(b) 30

(c) 54

(d) 40

৩৮. $x + \frac{1}{x} = \sqrt{3}$, $x^3 + \frac{1}{x^3} = ?$

(a) 2

(b) 4

(c) 0

(d) 6

৩৯. ইন্ডিয়া বাংলাদেশ যৌথ বিদ্যুৎ সঞ্চালন কেন্দ্রের মাধ্যমে যে পরিমাণ বিদ্যুৎ বাংলাদেশে Import এর চুক্তি হয়েছে

(A) ৫০০ MW (B) ৪৫০ MW

(C) ১০০০ MW (D) কোনটিই নয়

৪০. কোনটি কম্পিউটার নেটওয়ার্ক নয়?

(A) MAN (B) LAN

(C) CAN (D) WAN

৪১. SDGs সূচকে বাংলাদেশের অবস্থান কত?

(A) ১১০ তম (B) ১২০ তম

(C) ১১৫ তম (D) কোনটিই নয়

৪২. নিচের কোন দেশ দুই মহাদেশে অবস্থিত?

(A) কানাডা (B) পানামা

(C) তুরস্ক (D) মিশর

৪৩. বাংলাদেশে বিদ্যুত উৎপাদনে প্রধান জ্বালানী-

(A) তেল (B) গ্যাস

বর্গক্ষেত্রটির ক্ষেত্রফল অপরিবর্তিত থাকবে?

- (A) 20% (B) 16.67%
(C) 15% (D) 30%

৩০. City B is 8 mile east of city A. City C is 6 miles north of city B. City D is 16 miles east of city C and city E is 12 miles north of city D. A to city E?

- (a) 10 miles (b) 20 miles
(c) 24 miles (d) 30 miles

৩১. For what value of $8^{2x-4} = 16^x$?

- (a) 2 (b) 6
(c) 8 (d) 3

৩২. If $2^{x+5}=32$, what is the value of 3^{x+2} ?

- (a) 25 (b) 90
(c) 81 (d) 100

৩৩. Solve it: $\frac{\sqrt{5}+\sqrt{(5-x)}}{\sqrt{5}-\sqrt{(5-x)}}=5$

- (a) $\frac{20}{9}$ (b) $\frac{25}{9}$
(c) $\frac{15}{9}$ (d) 8

৩৪. Vowel গুলি একসাথে রেখে ACCLAIM শব্দটিকে কতবার সাজানো যাবে?

- (A) 90 (B) 180
(C) 240 (D) 360

৩৫. একটি ৪৮ মি লম্বা খুটি ভেঙ্গে গিয়ে সম্পূর্ণভাবে বিচ্ছিন্ন না হয়ে ভূমির সাথে ৩০° কোন উতপন্ন করে। খুটিটি কত উচুতে ভেঙেছিল?

- (A) ১৪ মিটার (B) ১৬ মিটার
(C) ১৮ মিটার (D) ২০ মিটার

৩৬. Rashed drove from his home to University at 60 miles per hour. Returning over the same route, there was a lot of traffic and he was only able to drive at 40 miles per hour. If the return trip took 1 hour longer, how many miles did he drive each way?

- (a) 20 (b) 100 (c) 60 (d) 120

(C) কয়লা (D) সৌরশক্তি

৪৪. কাপ্তাই ড্যাম কোন জেলায় অবস্থিত?

- (A) চট্টগ্রাম (B) কক্সবাজার
(C) রাংগামাটি (D) বান্দরবান

৪৫. স্বাধীনতার প্রথম ডাকটিকিটে কোন ছবি ছিল?

- (A) সোনা মসজিদ (B) জাতীয় স্মৃতিসৌধ
(C) উত্তরা গনভবন (D) শহীদ মিনার

৪৬. রোহিংগা ফেরতের জন্যে যে চুক্তিটি কিছুদিন আগে স্বাক্ষরিত হয়েছে-

- (A) রেংগুন (B) নেপিডো
(C) আরাকান (D) বাংলাদেশ

৪৭. গ্যালভানাইজিং এর কাজে ব্যবহৃত হয় কোন ধাতু?

- (A) কপার (B) জিংক
(C) অ্যালুমিনিয়াম (D) সিলভার

৪৮. কোন ইউরোপীয় রাষ্ট্র বাংলাদেশকে প্রথম স্বীকৃতি দেয়?

- (A) জার্মানী (B) যুক্তরাজ্য
(C) সুইডেন (D) পোল্যান্ড

৪৯. বাংলাদেশের দীর্ঘতম নদ ও নদী যথাক্রমে-

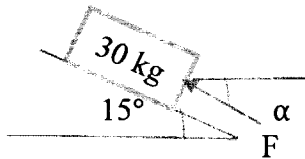
- (A) ব্রহ্মপুত্র ও মেঘনা (B) পদ্মা ও যমুনা
(C) ব্রহ্মপুত্র ও যমুনা (D) মেঘনা ও ব্রহ্মপুত্র

৫০. পদ্মা সেতু প্রকল্পে মূলসেতু নির্মাণের কার্যাদেশ প্রাপ্ত কোম্পানী কোনটি?

- (A) চায়না মেজর ইঞ্জিনিয়ারিং (B) এসএনসি লাভালিন
(C) হুদাই (D) জাপান ইনফ্রাস্ট্রাকচার ডেভেলপমেন্ট কোম্পানী

Departmental

1.(a) A box of mass 30 kg is lying on a rough inclined plane at an angle of 15° with the horizontal. Determine the smallest force value and the direction of the box.

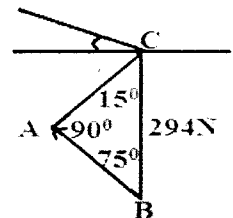


Solution:

Here, $\sin 15^\circ = \frac{AB}{BC}$;

$\Rightarrow AB = 294 \times \sin 15^\circ = 76.1$

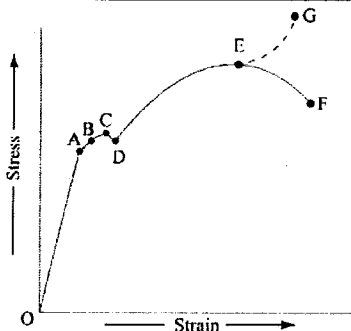
$\therefore F = 76.1 \text{ N}$ And $\alpha = 15^\circ$ (Answer)



1. (b) Write the differences between stress and pressure. Draw a typical stress-strain diagram of mild steel showing Yield strength and Ultimate strength.

Solution:

Pressure	Stress
1. Pressure is the magnitude of external force applied at a point	1. Stress is the magnitude of internal resisting force.
2. Pressure always acts normal to the surface	2. Stress acts normal or parallel to the surface.
3. Due to pressure, stress will be developed.	3. Due to stress, pressure will not be developed.
4. Magnitude of pressure at all points in all direction remains same.	4. Magnitude of stress at a point in different direction is unequal.



- A- Proportional limit
- B- Elastic limit
- C- Upper yield point
- D- lower yield point
- E- Ultimate stress/strength
- F- Breaking stress/strength
- G- Actual Rupture Strength

2. The percentage composition by mass of a sample of coal as found by analysis is given as C=80%; $H_2 = 4.3\%$; $O_2 = 3\%$; $N_2 = 0.7\%$; S=1%; ash=2%.

(i) Calculate the minimum mass of air required for the complete combustion of 1 kg of coal.

(ii) If 40% excess air is supplied find the percentage composition of the dry flue gases by volume.

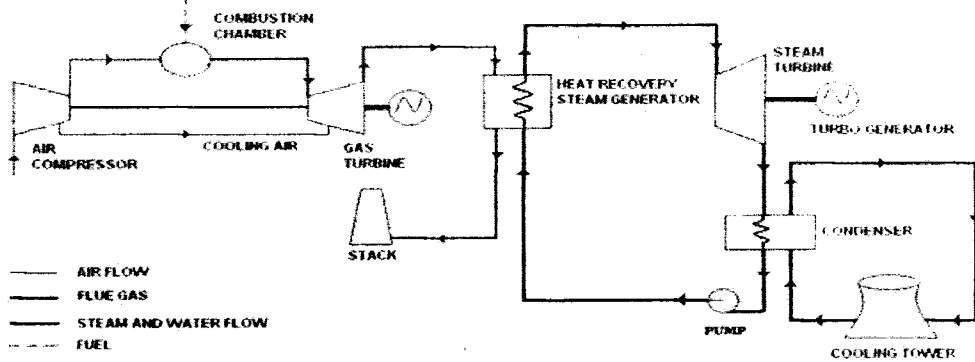
Solution:(i) Given, C=80%=0.8 kg ; $H_2 = 4.3\% = 0.043$ kg ; $O_2 = 3\% = 0.03$ kg ;

$N_2 = 0.7\% = 0.007$ kg ; S=1%=0.01 ; ash=2%=0.02 kg;

Air required to complete combustion of 1 kg coal

$$\begin{aligned}
 &= \frac{100}{23} \left[\left(\frac{8}{3} C + 8H_2 + S \right) - O_2 \right] \text{ kg} \\
 &= \frac{100}{23} \left[\left(\frac{8}{3} \times 0.8 + 8 \times 0.043 + 0.01 \right) - 0.03 \right] \text{ kg} \\
 &= 10.684 \text{ kg (Answer)}
 \end{aligned}$$

3. (a) Draw a schematic combined cycle diagram of Gas turbine-Steam turbine plant.



3.(b) A power plant has the following annual factors: load factor=90% ; Plant capacity factor=40% ; Plant use factor=45% .Maximum demand is 15 MW. Estimate (i) Annual energy production. (ii) The reserve capacity over and above the peak load and (iii) Hours during which the plant is not in service per year.

Solution:

a) Load factor = $\frac{\text{Average Load}}{\text{Maximum Demand}}$

\Rightarrow Average load = $0.90 \times 15 = 13.5 \text{ MW}$

\therefore Annual energy production = $13500 \text{ KW} \times 8760 \text{ h} = 118.26 \times 10^6 \text{ KWh (Answer)}$

b) Capacity factor = $\frac{\text{Average load}}{\text{Plant Capacity}}$

\Rightarrow Plant capacity = $\frac{13.5}{0.4} = 33.75 \text{ MW (Answer)}$

\therefore Reserve capacity over and above the peak load = $33.75 - 15 = 18.75 \text{ MW}$

c) Use factor = $\frac{\text{Energy generated per year}}{\text{plant capacity} \times \text{hours in operation}}$

\Rightarrow Hours in operation = $\frac{118.26 \times 10^6}{33.75 \times 10^3 \times 0.45} = 7786.7 \text{ hrs}$

\therefore Hours not in service in year = $8760 - 7786.7 = 973.3 \text{ hrs (Answer)}$

4.(a) A piezometer and a Pitot tube are tapped into a horizontal water pipe as shown in the figure. To measure static and stagnation pressure. For the indicated water column heights . Determine the velocity of water.

Solution: Here,

$$P_1 = \rho g(h_1 + h_2)$$

$$P_2 = \rho g(h_1 + h_2 + h_3)$$

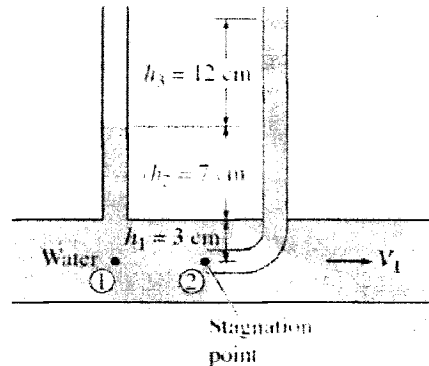
$$\text{We get, } \frac{P_1}{\rho g} + \frac{v_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + Z_2$$

$$\Rightarrow \frac{P_1}{\rho g} + \frac{v_1^2}{2g} = \frac{P_2}{\rho g}$$

$$\Rightarrow \frac{v_1^2}{2g} = \frac{\rho g(h_1 + h_2 + h_3) - \rho g(h_1 + h_2)}{\rho g} = h_3$$

$$\Rightarrow v_1^2 = 2gh_3$$

$$\Rightarrow v_1 = \sqrt{2gh_3} = 1.53 \text{ m/s (Answer)}$$



4.(b) Name the components of a nuclear power plant .write down the working principle of a nuclear power plant. Name some fuels used in a nuclear power plant.

Solution: Components of a Nuclear Power plant are:

- 1.Reactor assembly
- 2.Steam generator
- 3.Power generator
- 4.Fuel handler
- 5.Safety system
- 6.Control room

Most nuclear fuels contain heavy fissile actinide elements that are capable of undergoing and sustaining nuclear fission. The three most relevant fissile isotopes are Uranium-233, Uranium-235 and Plutonium-239.

5. (a) Write the difference between Refrigeration and Air-Conditioning. Draw a schematic diagram of a vapour compression refrigeration system. What is the function of expansion device in the system?

Solution:

Refrigeration	Air Conditionar
1.Refrigeration removes heat from enclosed space	1. AC cools air and it circulates in the enclosed space.
2. Refrigeration has no air quality control system.	2. AC controls the air quality for human comfort
3. No humidifier or dehumidifier used in refrigerator.	3. Humidifier or dehumidifier is used in AC.

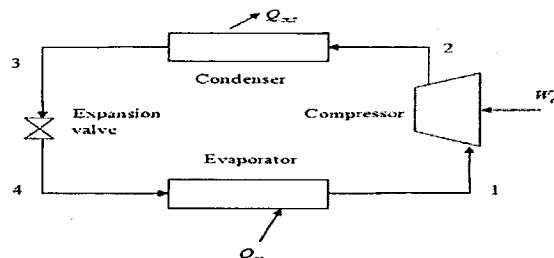
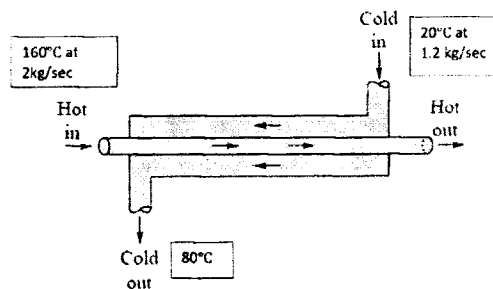


Fig: Schematic diagram of vapour compression refrigeration system

Function of expansion device in Refrigeration system: The expansion valve removes pressure from the liquid refrigerant to allow expansion or change of state from a liquid to a vapor in the evaporator. The high-pressure liquid refrigerant entering the expansion valve is quite warm. This may be verified by feeling the liquid line at its connection to the expansion valve.

5.(b) A counter flow double pipe heat exchanger is to heat water from 20°C to 80°C at a rate of 1.2kg/sec. The heating is to be accomplished by geothermal water available at 160°C at a mass of 2 kg/sec. The inner tube is thin-walled and has a diameter of 1.5 cm. If the Overall heat transfer co-efficient of the heat exchanger is 640W/m²°C. Determine the length of the heat exchanger required to achieve the desired heating. Take the specific heat of water and geothermal fluid is 4.18 and 4.31 KJ/kg°C respectively.

Solution:



The rate of heat transfer of the heat exchanger can be determine as

$$Q = mc_p(T_{\text{out}} - T_{\text{in}})_{\text{water}} = 1.2 \times 4.18 \times (80 - 20) = 301 \text{ kW}$$

The outlet temperature of the geothermal can be determine as,

$$Q = mc_p(160 - T)_{\text{geothermal}} = 301 \text{ kW}$$

$$\therefore T_{\text{out, geothermal}} = 125^\circ\text{C}.$$

$$\text{Now, } \Delta T_1 = 160 - 80 = 80^\circ\text{C}$$

$$\Delta T_2 = 125 - 20 = 105^\circ\text{C}$$

$$\Delta T_{\text{lm}} = \frac{\Delta T_1 - \Delta T_2}{\ln\left(\frac{\Delta T_1}{\Delta T_2}\right)} = 91.9^\circ\text{C}$$

$$\text{Now, } Q = UA_s \Delta T_{\text{lm}} = 640 \times \pi \times D \times L \times 91.9^\circ\text{C} = 301 \times 10^3$$

$$\therefore L = 109 \text{ m (Answer)}$$

6.(a) What is the role of mechanical engineers in power generation and distribution in Bangladesh (Not more than 500 words).

6.(b) What is the effect on the “North Side” of Bangladesh for sufficient electricity in every house? (Not more than 500 words).

Bankers Selection Committee (Three Banks Combined Exam)**Post: Assistant Engineer****Date: February/ March-2019****Full Marks-200****Departmental- 8×15= 120**

1. Find the thickness for a tube of internal diameter 100 mm subjected to an internal pressure, which is $\frac{5}{8}$ of the value of the maximum permissible circumferential stress. Also find the increase in internal diameter of such a tube when the internal pressure is 90 N/mm^2 . Take $E = 205 \text{ kN/mm}^2$ and $\mu = 0.29$. Neglect longitudinal strain.

Solution: Given, $D=100\text{mm}$; $P = \frac{5}{8} \sigma_t$

We get, $\sigma_t = \frac{PD}{2t}$

$$\Rightarrow t = \frac{P}{\sigma_t} \times \frac{D}{2} = \frac{5}{8} \times \frac{100}{2} = 31.25 \text{ mm (Answer)}$$

We know that increase in diameter of a tube,

$$\Delta D = \frac{P_1 D^2}{2tE} \left(1 - \frac{\mu}{2}\right) = \frac{90 \times 100^2}{2 \times 31.25 \times 205 \times 10^3} \left(1 - \frac{0.29}{2}\right) = 0.06 \text{ mm (Answer)}$$

2. The centrifugal pump delivers water against a net head of 14.5m and at design speed of 1000rpm. The vanes are curved back at an angle of 30° with the periphery. The impeller diameter is 300mm and outlet width 50mm. Determine the discharge of the pump, if the Manometric efficiency is 95%.

Solution: Given, $H_m=14.5\text{m}$; $N=1000\text{rpm}$; $\phi=30^\circ$; $D_2 = 0.3\text{m}$; $B_2 = 0.05\text{m}$; $\eta_{\text{mano}} = 0.95$

$$\therefore U_2 = \frac{\pi D_2 N}{60} = \frac{\pi \times 0.3 \times 1000}{60} = 15.707 \text{ m/s}$$

We get, $\eta_{\text{mano}} = \frac{H_m}{\frac{V_{w2} U_2}{g}}$

$$\Rightarrow 0.95 = \frac{14.5}{\frac{V_{w2} \times 15.707}{g}}$$

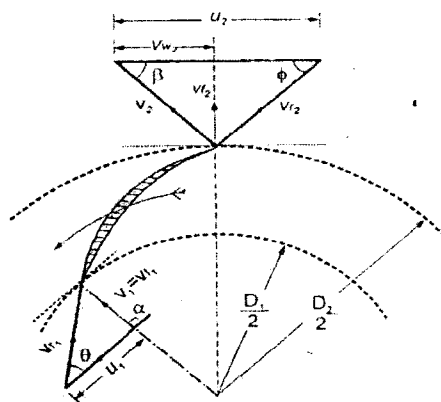
$$\therefore V_{w2} = 9.532 \text{ m/s}$$

From outlet velocity triangle,

$$\tan \phi = \frac{V_{f2}}{U_2 - V_{w2}}$$

$$\Rightarrow V_{f2} = 3.566 \text{ m/s}$$

$$\therefore Q = \pi D_2 B_2 V_{f2} = \pi \times 0.3 \times 0.05 \times 3.566 = 0.168 \text{ m}^3/\text{s (Answer)}$$



3. A diesel engine having bore 100 mm and stroke 120 mm, Cut off volume is 6% of swept volume and clearance volume is 10% of swept volume. Determine air standard efficiency.

Solution: Given, $D = 100\text{mm} = 0.1\text{m}$; $L = 120\text{mm} = 0.12\text{m}$

Clearance volume, $V_c = \frac{10}{100} V_s$

$$\therefore \frac{V_s}{V_c} = \frac{100}{10}$$

$$\Rightarrow \frac{V_c + V_s}{V_c} = \frac{100 + 10}{10}$$

$$\therefore r = 11; \text{ Again, } r = \frac{V_1}{V_2} = 11$$

Cut off volume = 6% of swept volume

$$\therefore V_3 - V_2 = 0.06 \times (V_1 - V_2)$$

$$\text{Let, } V_2 = 1; V_1 - V_2 = 11 - 1 = 10$$

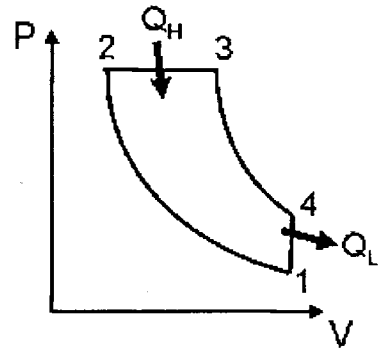
$$\Rightarrow V_3 - V_2 = 0.06 \times 10 = 0.6$$

$$\Rightarrow V_3 = 1 + 0.6 = 1.6$$

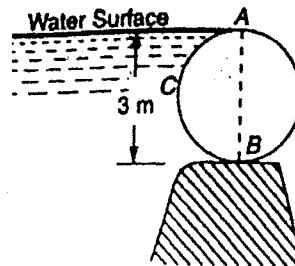
$$\rho = \frac{V_3}{V_2} = 1.6$$

$$\therefore \eta = 1 - \frac{1}{r^{\gamma-1}} \left[\frac{\rho^{\gamma}-1}{\gamma(\rho-1)} \right] = 1 - \frac{1}{11^{0.4}} \left[\frac{(1.6)^{1.4}-1}{1.4(0.6)} \right] = 0.5753$$

$$= 57.53\% \text{ (Answer)}$$



4. A roller gate of cylindrical form 3.0 metres in diameter has a span of 10 metres. Find the magnitude and direction of resultant force acting on the gate, when it is placed on the dam and the water level is such that it is going to spill.



Solution: Given, dia. Of gate = 3m; span = 10m and depth of water = 3m.

We get, Vertical area of the roller gate, $A = 3 \times 10 = 30 \text{ m}^2$

And depth of c.g. of the vertical area of the gate, $\bar{h} = \frac{3}{2} = 1.5 \text{ m}$

$$\therefore \text{Horizontal pressure on the roller gate, } P_H = \rho g A \bar{h} = 1000 \times 9.81 \times 30 \times 1.5 = 441500 \text{ N} = 441.5 \text{ kN}$$

\therefore Vertical pressure on the roller gate, $P_V = \text{weight of the imaginary water lying in the curved portion ACB} = 9.81 \left[\frac{1}{2} \times \frac{\pi}{4} \times 3^2 \times 10 \right] = 346.7 \text{ kN}$

$$\therefore \text{Resultant force acting on the gate, } P = \sqrt{P_H^2 + P_V^2} = \sqrt{441.5^2 + 346.7^2} = 561.4 \text{ kN (Answer)}$$

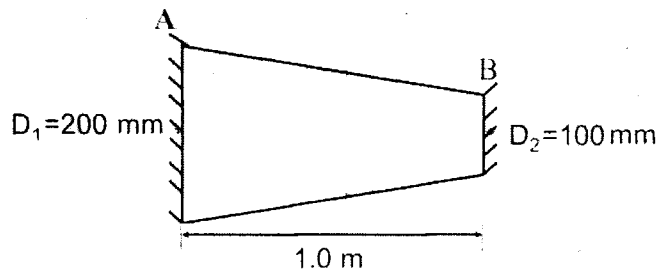
Direction of the resultant force:

$\alpha =$ Angle which the resultant force makes with the horizontal.

We know that, $\tan \alpha = \frac{P_v}{P_H} = \frac{346.7}{441.5} = 0.7853$ or, $\alpha = 38.1^\circ$ (Answer)

5. A circular section tapered bar is rigidly fixed as shown in figure. If the temperature is raised by 30°C , calculate the maximum stress in the bar.

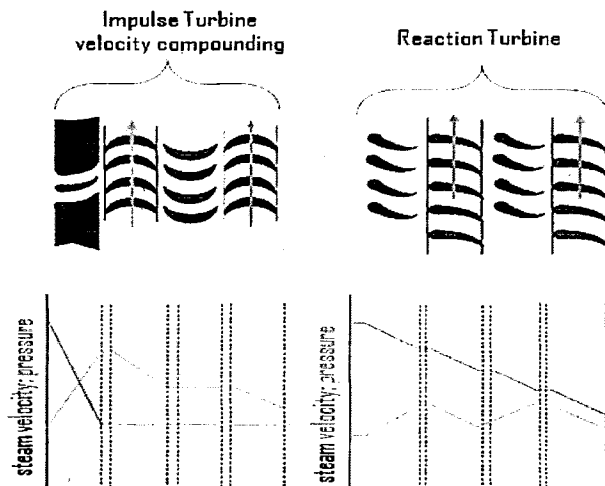
Take $E=2 \times 10^5 \text{ N/mm}^2$; $\alpha = 12 \times 10^{-6} / ^\circ\text{C}$ [similar]



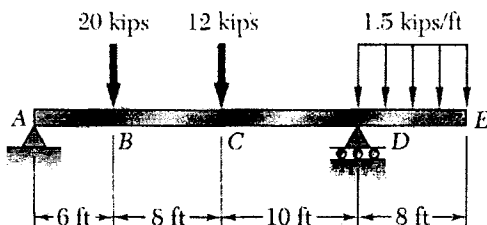
Solution: We get, maximum stress $= \frac{\alpha E \Delta T D_1}{D_2} = \frac{12 \times 10^{-6} \times 2 \times 10^5 \times 30 \times 0.20}{0.1} = 144 \text{ MPa}$ (Answer)

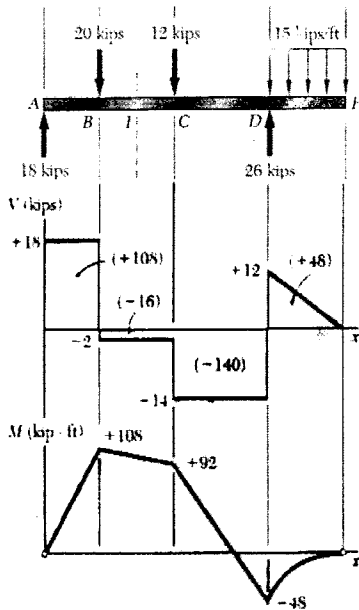
6. Draw Pressure -Velocity compounding for impulse turbine & reaction turbine. [Similar]

Answer:



7. Find SFD and BMD.





$$\sum M_A = 0$$

$$0 = D(24 \text{ ft}) - (20 \text{ kips})(6 \text{ ft}) - (12 \text{ kips})(14 \text{ ft}) - (12 \text{ kips})(28 \text{ ft})$$

$$D = 26 \text{ kips}$$

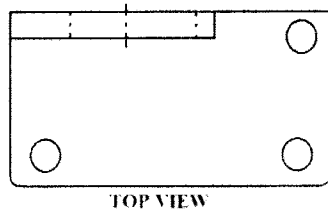
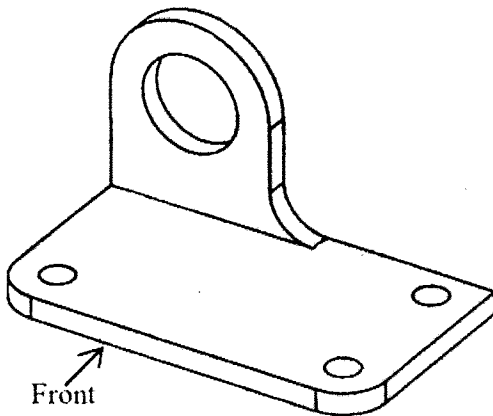
$$\sum F_y = 0$$

$$0 = A_y - 20 \text{ kips} - 12 \text{ kips} + 26 \text{ kips} - 12 \text{ kips}$$

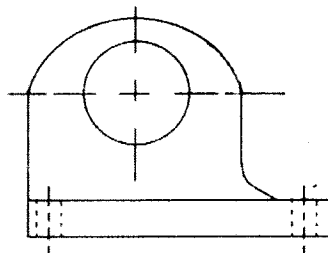
$$A_y = 18 \text{ kips}$$

9. Draw stress-strain diagram of mild steel.

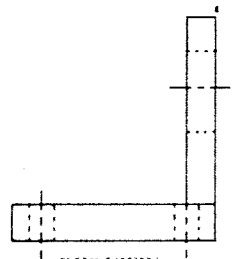
10. Draw TOP VIEW, FRONT VIEW and RHS VIEW.



TOP VIEW



FRONT VIEW



RHS VIEW

Non Departmental (80)

Marks for (1-2)=2×10=20

1. A train overtakes two persons walking along a railway track. The first one walks at 4.5 km/hr. The other one walks at 5.4 km/hr. The train needs 8.4 and 8.5 seconds

respectively to overtake them. What is the speed of the train if both the persons are walking in the same direction as the train?

Solution: Here, $4.5 \text{ km/hr} = 1.25 \text{ m/sec}$ and $5.4 \text{ km/hr} = 1.5 \text{ m/sec}$

Let the speed of the train be $x \text{ m/sec}$.

$$\text{Then, } (x - 1.25) \times 8.4 = (x - 1.5) \times 8.5$$

$$\Rightarrow 8.4x - 10.5 = 8.5x - 12.75$$

$$\Rightarrow 0.1x = 2.25$$

$$\Rightarrow x = 22.5$$

\therefore Speed of the train $= 22.5 \text{ m/s} = 81 \text{ km/hr}$ (Answer)

2. Two boats on opposite banks of a river start moving towards each other. They first pass each other 1400 meters from one bank. They each continue to the opposite bank, immediately turn around and start back to the other bank. When they pass each other a second time, they are 600 meters from the other bank. We assume that each boat travels at a constant speed all along the journey. What is the width of the river?

Solution:

Let V_1 and V_2 be the constant speeds of the two boats and t_1 the time when they first pass each other and t_2 the time when they pass each other for the second time. Let x the width of the river.

For First time passing,

1st boat,

$$V_1 t_1 = 1400$$

$$\therefore V_1 = \frac{1400}{t_1}$$

2nd boat,

$$V_2 t_1 = x - 1400$$

$$\therefore V_2 = \frac{x - 1400}{t_1}$$

$$\therefore V_1 + V_2 = \frac{1400}{t_1} + \frac{x - 1400}{t_1} = \frac{x}{t_1} \dots \dots \dots (i)$$

For second time passing,

1st boat,

$$V_1 t_2 = x + 600$$

2nd boat,

$$V_2 t_2 = x + x - 600$$

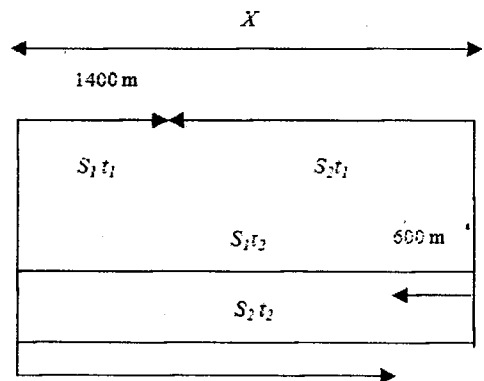
$$\therefore V_1 + V_2 = \frac{x + 600}{t_2} + \frac{2x - 600}{t_2} = \frac{3x}{t_2} \dots \dots \dots (ii)$$

$$\text{From equation (i) \& (ii)} \Rightarrow \frac{x}{t_1} = \frac{3x}{t_2}$$

$$\therefore t_2 = 3t_1$$

For 1st Boat of two time passing,

$$\frac{1400}{t_1} = \frac{x + 600}{t_2}$$



$$\Rightarrow \frac{1400}{t_1} = \frac{x+600}{3t_1}$$

$$\Rightarrow 4200 = x + 600$$

$$\therefore x = 3600 \text{m (Answer)}$$

3. Translation Bangla to English and English to Bangla = 20

4. Essay writing (English Green banking, Bangla ক্ষুদ্র ও মাঝারি শিল্প) 20×2= 40

Green Banking

Green banking is a process of promoting environment friendly practices by different banking activities. Bangladesh is a most climate change vulnerable country in the world and green banking is a tool for acquiring reputation. Green bankers are concerned about sustainable development and it is a special agenda to take care of environment of the earth. Green banking is a proactive and effective step with a vision for future sustainability. Green banking activities are sustainable banking, ethical banking, green money market account, mobile banking, waste management, remote deposit and green financing. Green banking focuses on green transformation of internal operations of all banks.

There are many differences compared with normal banking, they give more weight to environmental factors, their aim is to provide good environmental and social business practice, they check all the factors before lending a loan, whether the project is environmental friendly and has any implications in the future, you will awarded a loan only when you follow all the environmental safety standards.

Basically Ethical banking avoids as much as paper work, you get go green credit cards, go green mortgages and also all the transactions done through online. Creating awareness to business people about environmental and social responsibility enabling them to do a environmental friendly business practice. They follow environmental standards for lending, which is really a good idea and it will make business owners to change their business to environmental friendly which is good for our future generations. When you are awarded with a loan, the interest of that loan is comparatively less with normal banks, because ethical banks give more importance to environmental friendly factors they do not operate with high interest rates. Overall Green banking is really a good way for people to get more awareness about global warming. Each businessman will contribute a lot to the environment and make this earth a better place to live.

In Bangladesh Bank's Recent Reform Initiatives, it has been written that green banking products are those that help create a favorable impact on the environment. As part of the Rio+20 Summit, Bangladesh and Vietnam jointly organized a side event on June 19, 2012, in Rio de Janeiro, Brazil to discuss how to ensure green development in the backdrop of a rapidly changing climate. On February 27, 2011, the Banking Regulation and Policy Department of the Bangladesh Bank issued a circular to all scheduled banks to take necessary steps towards initiating and implementation of green banking in each bank.

ক্ষুদ্র ও মাঝারি শিল্প

একটি উন্নয়নশীল দেশের সার্বিক অর্থনৈতিক উন্নয়নে ক্ষুদ্র ও মাঝারি শিল্পের (এসএমই) ব্যাপক ভূমিকা রয়েছে। এমনকি সমৃদ্ধিশালী দেশের অর্থনৈতিক উন্নয়নেও এ খাতের অবদান রয়েছে। খাতটি শ্রমঘন। এর উৎপাদন সময় তুলনামূলকভাবে স্বল্প। ফলে জাতীয় আয় বৃদ্ধি ও কর্মসংস্থান সৃষ্টিতে বিশেষ ভূমিকা রাখে। বাংলাদেশও অর্থনৈতিক প্রবৃদ্ধি অর্জন, আয়বৈষম্য কমিয়ে আনা, দারিদ্র্য বিমোচন প্রভৃতি লক্ষ্য অর্জনে এসএমই খাতের ওপর গুরুত্ব আরোপ করতে পারে। এ লক্ষ্যে পৌঁছাতে বাংলাদেশ ব্যাংকের কয়েকটি পদক্ষেপ দেখে নিতে পারেন।

ক্ষুদ্র ও মাঝারি শিল্পের বিকাশ ও সম্প্রসারণে বাংলাদেশ ব্যাংক আন্তরিক। এজন্য বেশ কয়েকটি স্কিম ও কর্মসূচি নিয়েছে। আইডিএ ও এডিবি তহবিল থেকে সুলভে পুনঃঅর্থায়ন স্কিমে অর্থায়ন করেছে বাংলাদেশ ব্যাংক। সহজ শর্তে প্রাতিষ্ঠানিক আর্থিক সুবিধা নিশ্চিতকরণে কাজ করেছে। এজন্য ব্যাংকগুলোয় এসএমই খাতের জন্য ডেডিকেটেড ডেস্ক চালু করা হয়েছে। এসএমই সার্ভিস সেন্টার খোলা হয়েছে। নারী উদ্যোক্তাদের জন্য বিশেষ সুবিধা প্রবর্তনের পাশাপাশি বহুমুখী পদক্ষেপ নেওয়া হয়েছে। বাংলাদেশ ব্যাংকের প্রধান কার্যালয়ে এসএমই ও স্পেশাল প্রোগ্রামস বিভাগসনামে একটি বিভাগ রয়েছে। বিভাগটি এসএমই খাতের উন্নয়নে নীতিনির্ধারণ, মনিটরিং ও তহবিল সরবরাহ করবে। উদ্যোক্তা গঠন ও উন্নয়ন কর্মসূচিতে সহায়তাকারীর ভূমিকা পালন করবে।

BUET MSc Admission -2018

[October Term]

Date: 13.11.2018

Time: 6.00PM to 7.00PM

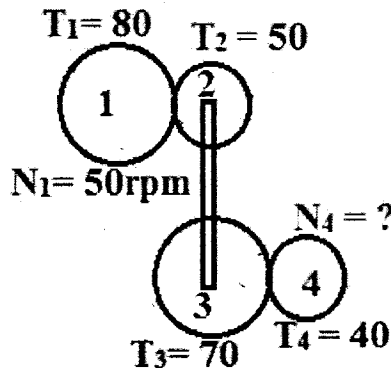
Marks: 12×5=60

Exam Hall: EME Building, BUET

1. Matching the table:

Somerfield Number	Journal bearing
Shaper machine	Quick return motion mechanism
Foundry lab	Molding

2. Find the speed of gear 4.



Solution:

$$\frac{N_1}{N_2} \times \frac{N_3}{N_4} = \frac{T_2}{T_1} \times \frac{T_4}{T_3}$$

$$\Rightarrow \frac{N_1}{N_4} = \frac{T_2}{T_1} \times \frac{T_4}{T_3} [\because N_3 = N_2]$$

$$\Rightarrow \frac{50}{N_4} = \frac{50}{80} \times \frac{40}{70} = \frac{20}{56}$$

$$\Rightarrow N_4 = \frac{50 \times 56}{20} = 140 \text{ rpm (Answer)}$$

3. A cantilever beam with diameter 100mm, length 3m is subjected to a load of 5KN. Find the tip deflection if $E = 200 \text{ GPa}$.

Solution:

$$\delta = \frac{pl^3}{3EI} = \frac{5 \times 10^3 \times 3^3}{3 \times 200 \times 10^3 \times \frac{\pi}{64} \times 0.1^4} = 0.0458 \text{ m. (Answer)}$$

4. A steel bar of 2m length is under tensile load of 2KN. Find the minimum diameter of the bar if maximum allowable stress is 150MPa and maximum allowable deflection is 3mm.

Solution:

We get,

$$\delta = \frac{F}{A}$$

$$\Rightarrow A = \frac{2000}{150 \times 10^6}$$

$$\Rightarrow \frac{\pi}{4} d^2 = \frac{2000}{150 \times 10^6}$$

$$\Rightarrow d = 4.12 \text{ mm}$$

Again,

$$\delta = \frac{FL}{AE}$$

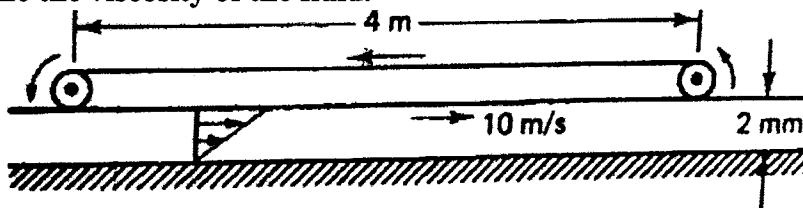
$$\Rightarrow A = \frac{2000 \times 2}{3 \times 10^{-3} \times 200 \times 10^9}$$

$$\Rightarrow \frac{\pi}{4} d^2 = \frac{2000 \times 2}{3 \times 10^{-3} \times 200 \times 10^9}$$

$$\Rightarrow d = 2.91 \text{ mm}$$

So, minimum diameter of the bar will be at least 4.12mm. (Answer)

5. 1KN force is required per unit area to give the belt 10 m/s at right side, as shown in figure, determine the viscosity of the fluid.

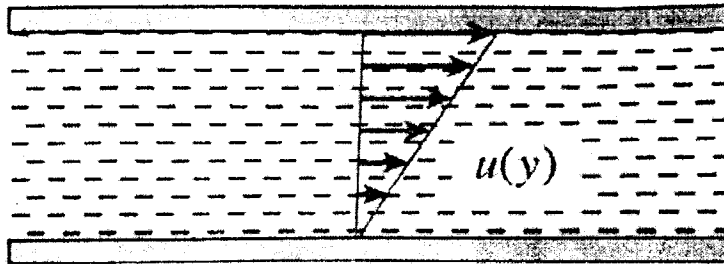
**Solution:**

$$\tau = \mu \frac{du}{dy}$$

$$\Rightarrow 1 \times 10^3 = \mu \times \frac{10}{0.002}$$

$$\Rightarrow \mu = 0.2 \text{ Pa.s (Answer)}$$

6. An equation of temperature was given $[T=f(y)]$, boundary condition was also given to find the constant term of the given temperature equation $[At, y=0, u=0]$, Find the heat flow rate from this plate.



7. Find out the efficiency for Otto cycle for the specific heat ratio (C_p/C_v) of the working fluid is considered as 1.50 and compression ratio is 10. If the cut-off ratio is 1.96 then what will be diesel cycle efficiency?

Solution: Given, $\gamma = 1.5$, $\rho = 1.96$, $r = 10$, $\eta_{\text{Otto}} = ?$ and $\eta_{\text{diesel}} = ?$

For Otto Cycle:

$$\eta_{\text{Otto}} = 1 - \frac{1}{(r)^{\gamma-1}}$$

$$\text{or, } \eta_{\text{Otto}} = 1 - \frac{1}{(10)^{1.5-1}}$$

$$\text{or, } \eta_{\text{Otto}} = 0.6837$$

$$\therefore \eta_{\text{Otto}} = 68.37\% \text{ (Answer)}$$

For Diesel Cycle:

$$\eta_{\text{diesel}} = 1 - \frac{1}{r^{\gamma-1}} \left[\frac{\rho^{\gamma}-1}{\gamma(\rho-1)} \right] = 1 -$$

$$\frac{1}{10^{0.5}} \left[\frac{(1.96)^{1.5}-1}{1.5(0.96)} \right]$$

$$= 0.6170 = 61.70\% \text{ (Answer)}$$

8. A 50hp engine has a thermal efficiency of 45%. If the calorific value of the fuel is 35 MJ/Kg, determine bsfc.

Solution:

Given, Power Output= 50hp; $\eta=45\%$; $C=35\text{MJ/Kg}$;

$$\text{We get, } \eta = \frac{\text{Power Output}}{\text{Power Input}}$$

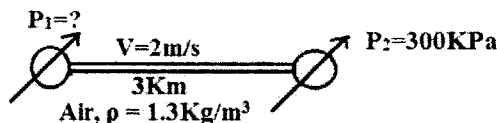
$$\therefore \text{Power Input} = \frac{50}{0.45} = 111.11 \text{ hp} = 82.85 \text{ KW}$$

$$\text{Power Input} = \dot{m}_f C = 82.85 \text{ KW}$$

$$\therefore \dot{m}_f = \frac{\text{Power Input}}{C} = \frac{82.85}{35 \times 10^3} = 0.0024 \text{ Kg/ sec}$$

$$\therefore \text{bsfc} = \frac{\dot{m}_f}{\text{Power Output}} = \frac{0.0024 \times 3600}{50 \times 0.746} = 0.232 \text{ Kg/KWh (Answer)}$$

9. Air is flowing at 2m/s in a 30mm diameter pipe. $f=0.03$



Solution:

$$\frac{P_A}{\rho g} + \frac{V_A^2}{2g} + z_A = \frac{P_B}{\rho g} + \frac{V_B^2}{2g} + z_B + h_f$$

$$\Rightarrow P_A = P_B + \rho g \times \frac{fLV^2}{2gd}$$

$$= 300 \times 10^3 + 1.3 \times \frac{0.03 \times 3000 \times 2^2}{2 \times 0.03}$$

$$\therefore P_A = 307.8 \text{ KPa} \quad (\text{Answer})$$

10. 80Kg iron at 80°C is dropped into 0.5m³ water at 25°C. Find the final temperature of water if heat capacity of iron is 0.45KJ/Kg.k.

Solution: Let, the final temperature is T °C.

$$\text{Mass of water} = \rho V = 1000 \times 0.5 = 500 \text{ kg}$$

$$\text{We get, } (mC_p \Delta T)_{\text{water}} = (mC_p \Delta T)_{\text{iron}}$$

$$\Rightarrow 500 \times 4.2 \times (T - 25) = 80 \times 0.45 \times (80 - T)$$

$$\Rightarrow T = 25.93^\circ\text{C}. \quad (\text{Answer})$$

11. A wall has the dimension of 3m×2m×0.2m, if the heat transfer coefficient of inside and outside of the wall is 10 W/m²K and 20W/m²K respectively then determine the heat flow rate through this wall. Thermal conductivity of wall material is 0.5 W/m²K and temperature difference is 10°C between inside and outside the wall.

Solution:

$$Q = \frac{\Delta T}{R_{th}} = \frac{\Delta T}{\frac{1}{h_i A} + \frac{1}{kA} + \frac{1}{h_o A}} = \frac{10}{\frac{1}{10 \times 6} + \frac{0.2}{0.5 \times 6} + \frac{1}{20 \times 6}} = 109 \text{ W}.$$

12. Drawing.

Bangladesh Bank (Assistant Director-ME)

Date of Exam: 11 Jan 2019

Venue: Govt. Science College, Farmgate, Dhaka.

Conducted By: AUST

Full Marks: 200 [170 Written + 30MCQ]

Time: 2hr

1. What are the selection factors of Boiler? Write the effect of Economizer and Superheater in a steam generating plant.

Answer: Selection factors of a Boiler

1. The Power required and the working pressure.
2. Rate at which steam is to be generated.
3. Geographical position of the power house.
4. Availability of fuel and water.
5. Type of fuel to be used.
6. Probable load factor.
7. Probable permanency of the station

Economiser: An economizer is a heat exchanger used for heating the feed water before it enters the boiler. The economizer recovers some of waste heat of hot flue gases going to the chimney. As the name indicates, the economizer improves the economy of the steam boiler.

Superheater: Superheater is also a heat exchanger. Its purpose is to increase the temperature of saturated steam without raising its pressure. The heat, given up by the flue gases, is used in superheating the steam by superheater.

2. A powerhouse is equipped with Pelton type impulse turbine. Each turbine delivers 14MW when working a head 900m and running 600 rpm. Find the diameter of the Jet and mean diameter of the wheel. Assume the overall efficiency is 89%, velocity coefficient 0.98 and speed ratio 0.46.

Solution: Power supplied by the water to the turbine = $\frac{14 \times 10^6}{0.89} = 15.73 \times 10^6 \text{ W}$

Flow rate, $Q = \frac{15.73 \times 10^6}{10^3 \times 9.81 \times 900} = 1.78 \text{ m}^3/\text{s}$

Inlet jet velocity is

$$V_1 = C_v \sqrt{2gH} = 0.98 \times \sqrt{2 \times 9.81 \times 900} = 130.22 \text{ m/s}$$

If d is the diameter of water jet, then

$$1.78 = \frac{\pi}{4} d^2 \times 130.22$$

$$\Rightarrow d = \left(\frac{4 \times 1.78}{\pi \times 130.22} \right)^{1/2} = 0.132 = 132 \text{ mm (Answer)}$$

Blade speed is $U = 0.46 \times 130.22 = 59.90 \text{ m/s}$

Hence mean diameter of the wheel

$$D = \frac{60U}{\pi N} = \frac{60 \times 59.90}{\pi \times 600} = 1.91 \text{ m (Answer)}$$

3. Water flows through a pipe of radius 8cm with a velocity of 10 m/s. When water enters a 3cm radius pipe, what is the velocity of water in 3cm radius pipe?

Solution: Here, $A_1 = \pi \times r_1^2 = \pi \times 8^2 = 64\pi \text{ cm}^2$ and $A_2 = \pi \times r_2^2 = \pi \times 3^2 = 9\pi \text{ cm}^2$

We get,

$$A_1 V_1 = A_2 V_2$$

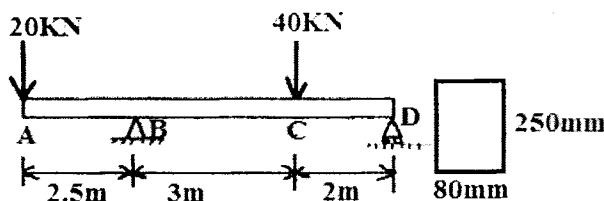
$$\Rightarrow 64\pi \times 10 = 9\pi \times V_2$$

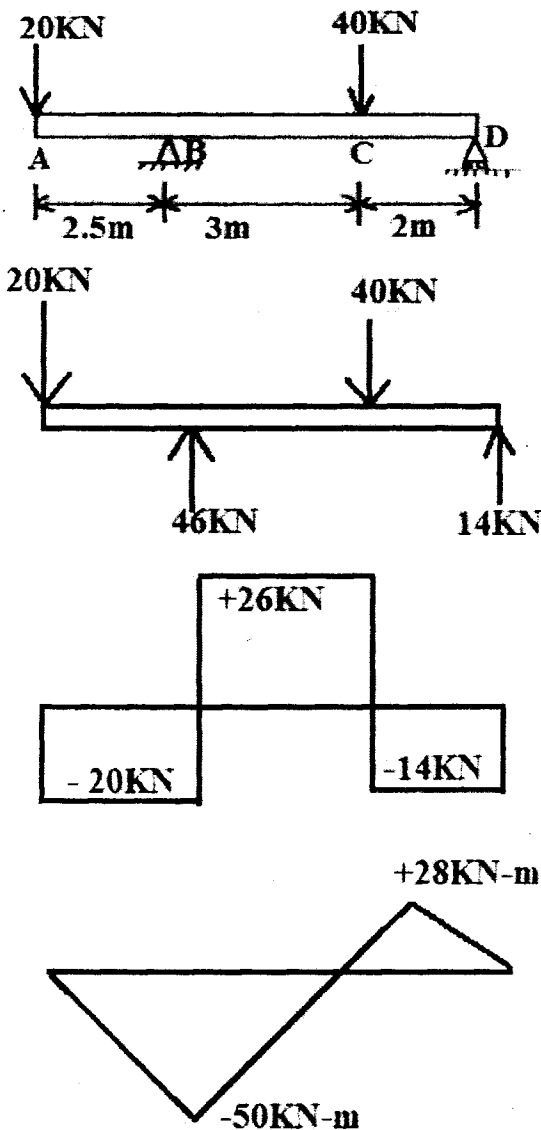
$$\Rightarrow V_2 = 71.11 \text{ m/s (Answer)}$$

4. Draw P-V diagram of Otto and Diesel cycle. In a diesel engine compression ratio 17 and fuel cutoff at 10% of the stroke. Find the air standard efficiency of the engine.

Answer: Same as Power Development Board (PDB)-2010 Question-9 and Power Grid Company Ltd.(PGCB)-2017 Question-10

5. Draw the shear force and bending moment diagram. Also determine minimum normal stress due to bending.





From $\sum F_y = 0$ and $\sum M_B = 0$

$$\therefore R_B = 40\text{KN and } R_D = 14\text{KN}$$

$$M_B = 50\text{KN-m}$$

$$S = \frac{1}{6} bh^2 = \frac{1}{6} \times 0.08 \times 0.25^2$$

$$= 833.33 \times 10^{-6} \text{ m}^3$$

$$\sigma_m = \frac{M_B}{S} = \frac{50 \times 10^3}{833.33 \times 10^{-6}}$$

$$\therefore \sigma_m = 60 \times 10^6 \text{ Pa (Answer)}$$

6. What are the principles of Management by H.Fayol which is widely used by manger and organization.

According to Henri Fayol there are 14 principle of Management.

1.Division of Work:

Henri Fayol said that specialization in work increases the productivity and improves efficiency. Division of labour also leads to the specialization, accuracy, and speed of the workers. This principle is applicable both in managerial as well as technical work.

2. Authority and Responsibility:

These are the two key things in management. While authority enables the management to delegate work, responsibility makes them accountable for any work done under their leadership.

3. Discipline**4. Unity of Command**

A person should ideally answer to just one boss. If an employee is given work from more than one boss, there arises a conflict of interest.

5. Unity of Direction

For any corporate to prosper, there must be a unified goal. The responsibility of planning falls on the manager and he also must monitor the progress towards said goal.

6. Subordination of Individual Interest:

This principle states that the interest of an individual will be subordinate to the objectives of the organization.

7. Remuneration

Remuneration may be monetary or non-monetary. At the end, the employee must feel that he was appropriately rewarded for his efforts.

8. Centralization

Henri Fayol said that there must be a balance in the hierarchy and division of power.

9. Scalar Chain

Henri Fayol talks about a clear line of hierarchy from the top rung to the lowest. So that every employee knows who is their immediate senior in the times of conflict or crisis.

10. Order

There must be a proper defined order maintained at the work premises so that it makes for a conducive work environment.

11. Equity

Employees should be treated with equality and respect. This is among the core values of management.

12. Stability

An employee is able to deliver better when he is secure in his job. It is the duty of the management to offer job security to their employees along with a promise of growth.

13. Initiative

Sometimes groundbreaking ideas come from unexpected places. The management must encourage its employees to take initiatives in the organization. It will make them feel valued and develop their interest.

14. Esprit de Corps

This is one of the core principles. The management must ensure that the team remains constantly motivated and are cooperative with each other.

7. Explain the term “Torsional Rigidity” and “Lateral Rigidity”. A hollow shaft is subjected to a torque 4MN-mm and bending moment 3MN-mm. Determine the diameter of the shaft. Maximum shear stress is 82 KN/mm^2 and internal diameter is half of the external diameter.

Answer;

Torsional rigidity: Torsional rigidity is the ability to resist twist under the action of an external torque. Mathematically it is defined as the product of modulus of rigidity (C) and polar moment of inertia of the shaft (J). Hence,

$$\text{Torsional rigidity} = C \times J$$

Torsional rigidity is also defined as the torque required to produce a twist of one radian per unit length of the shaft.

$$\text{Torsional rigidity} = \frac{T \times L}{\theta}$$

Lateral rigidity: Lateral rigidity is the ability to resist deflection under the action of external forces. So, it is the resistance against the bending deformation or the minimum force required to deform the object by bending.

Solution: We get, Maximum shear $\tau = \frac{16D}{\pi(D^4 - d^4)} \sqrt{M^2 + T^2}$

Here, Maximum shear $\tau = 82 \text{ KN/mm}^2 = 82 \times 10^9 \text{ N/mm}^2$; Bending moment = $3 \text{ MN-mm} = 3 \times 10^6 \text{ N-m}$; Torque = $4 \text{ MN-mm} = 4 \times 10^3 \text{ N-m}$ and $D = 2d$

$$\therefore 82 \times 10^9 = \frac{16 \times D}{\pi(D^4 - d^4)} \sqrt{(3 \times 10^3)^2 + (4 \times 10^3)^2} = \frac{16 \times D}{\pi(D^4 - d^4)} \times 5 \times 10^3$$

$$\Rightarrow 82 \times 10^9 = \frac{16 \times 2 \times d}{\pi(16d^4 - d^4)} \times 5 \times 10^3$$

$$\Rightarrow d^3 = 4.14 \times 10^{-8}$$

$$\therefore d = 0.0035 \text{ m} = 3.50 \text{ mm}$$

$$D = 7 \text{ mm}$$

Answer: External diameter 7 mm and internal diameter 3.50mm

8. With sketch describe four Lathe operation. What are the differences between face milling and peripheral milling.

Answer:

Facing:

Facing is the operation of machining the ends of a piece of work to produce flat surface square with the axis. The operation involves feeding the tool perpendicular to the axis of rotation of the work.

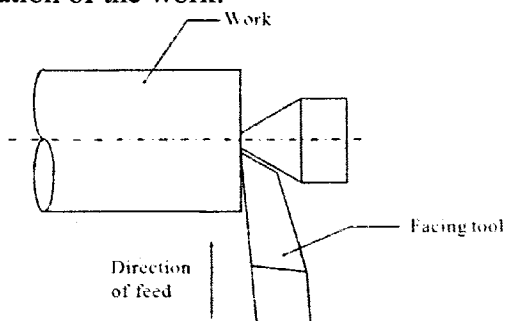


Fig.: Facing

Turning:

Turning in a lathe is to remove excess material from the workpiece to produce a cylindrical surface of required shape and size.

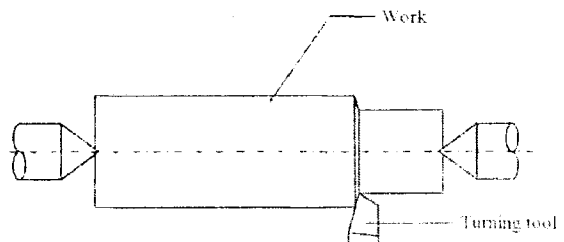


Fig.: Straight Turning

Chamfering:

Chamfering is the operation of bevelling the extreme end of the workpiece. The form tool used for taper turning may be used for this purpose. Chamfering is an essential operation after thread cutting so that the nut may pass freely on the threaded workpiece.

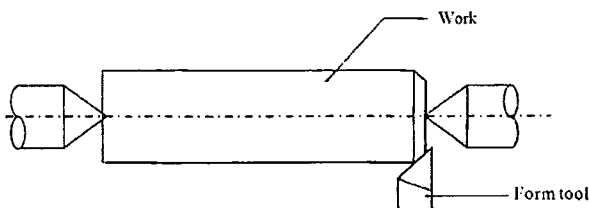


Fig.: Chamfering

Thread cutting:

Thread cutting is one of the most important operations performed in a lathe. The process of thread cutting is to produce a helical groove on a cylindrical surface by feeding the tool longitudinally.

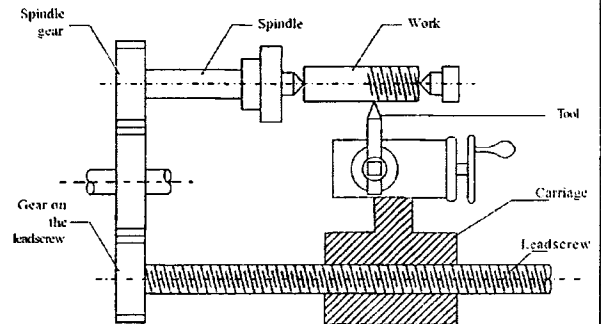


Fig.: Thread cutting

Differences between face milling and peripheral milling: These are the two broad categories of milling operations. In peripheral milling the teeth are located on the periphery of the cutter body and in face milling the teeth for cutting are on both the periphery and the face of the cutter.

In peripheral milling the surface of work piece is parallel with the axis of rotation of the cutter but in face milling it is at right angles to the cutter axis. .

Peripheral milling can be used for both flat and formed surface depending on the axial contour of the cutter. In face milling, while most of the cutting is done by the peripheral portions of the teeth, the face portion provides finishing action.

Peripheral milling is usually done on horizontal spindle machine, but face milling can be done on both horizontal and vertical spindle machines. Face milling produces a smoother surface than peripheral milling.

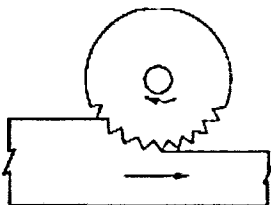


Fig.: Peripheral or slab milling

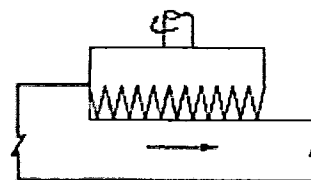


Fig.: Face milling

9. List the properties of good molding sand. Enumerate the defects in a sand casting and method to eliminate them.

Answer:

Properties of good molding Sand:

- Porosity or Permeability
- Flowability
- Collapsibility
- Adhesiveness
- Cohesiveness or Strength
- Refractoriness
- Green Strength
- Dry Strength

Casting defects and method of elimination:

1. Shift or Mismatch:

Remedies

- (i) Proper alignment of the pattern or die part, molding boxes.
- (ii) Correct mountings of pattern on pattern plates.
- (iii) Check the alignment of flask.

2. Swell

Remedies

- (i) The sand should be rammed properly and evenly.

3. Blowholes:

Remedies

- (i) The moisture content in the sand must be controlled and kept at desired level.
- (ii) High permeability sand should be used.
- (iii) Sand of appropriate grain size should be used.
- (iv) Sufficient ramming should be done.
- (v) Adequate venting facility should be provided.

4. Drop

Remedies

- (i) Sand of high strength should be used with proper ramming (neither too hard nor soft).
- (ii) There should be proper fluxing of molten metal, so the impurities present in molten metal is removed easily before pouring it into the mold.
- (iii) Sufficient reinforcement of the sand projections in the cope.

5. Metal Penetration

Remedies

- (i) This defect can be eliminated by using high strength, small grain size, low permeability and soft ramming of sand.

6. Pinholes

Remedies

- (i) By reducing the moisture content of the molding sand.
- (ii) Good fluxing and melting practices should be used.

- (iii) Increasing permeability of the sand.
- (iv) By doing rapid rate of solidification.

7. Shrinkage Cavity

Remedies

- (i) This defect can be removed by applying principle of directional solidification in mold design.
- (ii) Wise use of chills (a chill is an object which is used to promote solidification in a specific portion of a metal casting) and padding.

8. Cold Shut

Remedies

- (i) Improved gating system.
- (ii) Proper pouring temperature.

9. Misrun

Remedies

- (i) Increasing the pouring temperature of the molten metal increases the fluidity.
- (ii) Proper gating system
- (iii) Too thin section is avoided.

10. Slag Inclusion

Remedies

- (i) Remove slag particles from the molten metal before pouring it into the mold cavity.

11. Fins

Remedies

- (i) Correct assembly of the mold and cores.
- (ii) There should be sufficient weight on the top part of the mold so that the two parts fit together tightly.

10. Describe the summer and winter air conditioning system with diagram. What are the important factors that effect human comfort?

Answer:

Winter Air Conditioning System:

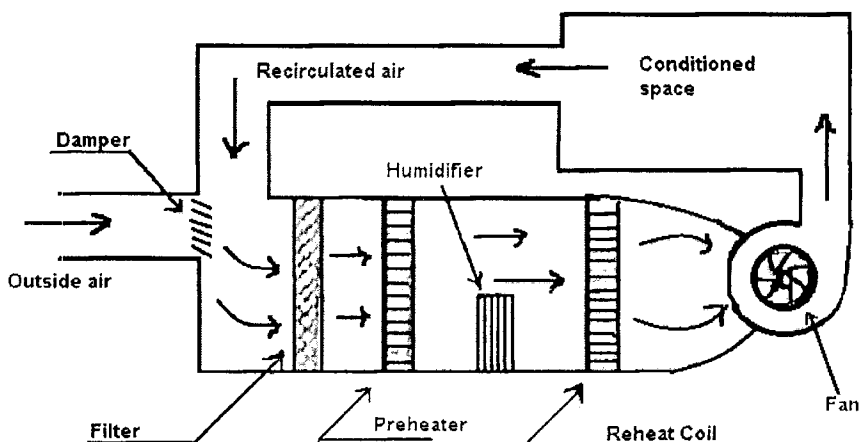


Fig.: Winter Air Conditioning

The outside air flows through a damper and mixes with the recirculated air. The mixed air passes through a filter to remove the dirt, dust, and impurities.

The air now passes through a preheat coil to prevent the possible freezing of water and to control the evaporation of water in the humidities. After that, the air is made to pass through a reheat coil to bring the air to the designed dry bulb temperature.

Now, the conditioned air is supplied to the conditioned space by a fan. From the conditioned space, a part of the air is exhausted to the atmosphere by the exhaust fans. The remaining part of the used air is again conditioned and this will repeat again and again.

Summer Air Conditioning:

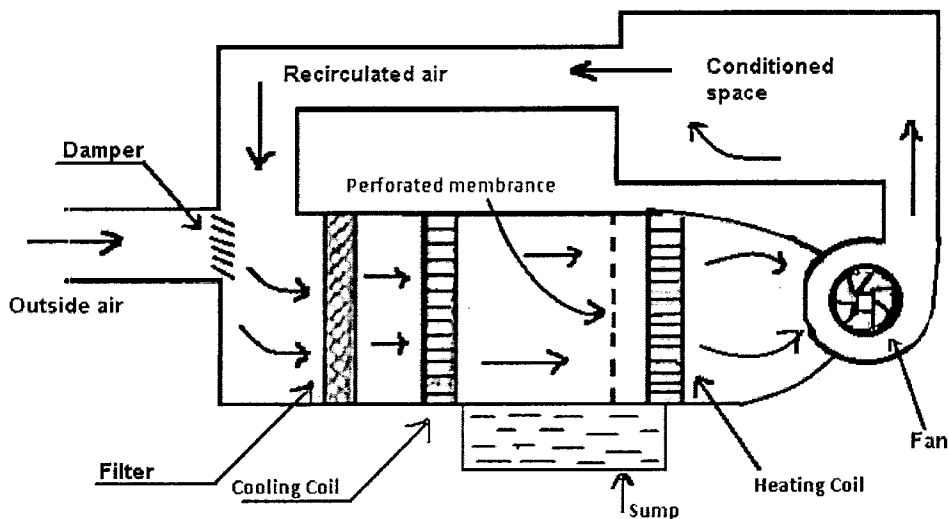


Fig.: Summer Air Conditioning

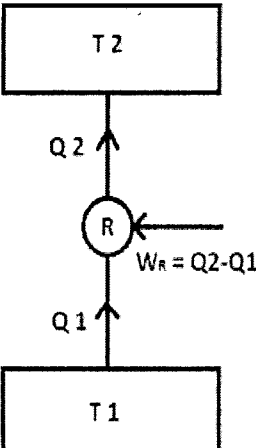
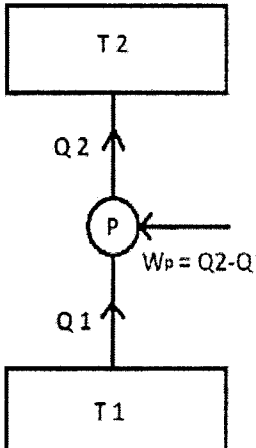
The outside air flows through the damper and mixed with recirculated air (which is obtained from the conditioned space). The mixed air passes through a filter to remove the dirt, dust and impurities.

The outside air is sucked and made to mix with recirculated air to make for the loss of conditioned air through exhaust fan from the conditioned space.

Factors affecting Comfort air conditioning:

- (i) Temperature of air
- (ii) Humidity of air
- (iii) Purity of air
- (iv) Motion of air
- (v) Clothing
- (vi) Sex and age
- (vii) Activity

11. Write the difference between refrigeration and heat pump. List commonly used refrigerant and the properties of good refrigerant.

Refrigerator	Heat Pump
 <p>A refrigerator is a reversed heat engine which cools and maintains the temperature of a body lower than the atmospheric temperature.</p> <p>This is done by the process of extracting heat from the cold body and then delivers it to a hot body. In the figure, Q_1 is the energy taken from the cold body and Q_2 is the energy given to T_2. Since $T_2 > T_1$, a work should be done to the system in order to make the process feasible.</p> <p>Here,</p> <p>T_2 will be equal to the atmospheric temperature.</p> <p>COP may be greater than, equal to or less than 1.</p> <p>The product is cold volume and $T_1 < T_a$</p> <p>Where, T_a = Atmospheric Temperature.</p>	 <p>There is no difference between a heat pump and a refrigerator in the case of its cycle of operation. The main difference between the heat pump and refrigerator is its operating temperatures. The working temperatures of a refrigerator are cold temperature T_1 and atmospheric temperature T_a. Whereas, for a heat pump, the working temperatures are atmospheric temperature and hot body temperature T_2.</p> <p>Here,</p> <p>$T_1 = T_a$</p> <p>COP always greater than 1.</p> <p>Hot volume is the product and $T_2 > T_a$.</p>

List of the Refrigerant:

Mostly used Refrigerants:

- R-134a (CH_2FCF_3 , boiling point: -26°C)
- R-410a (50% CH_2F_2 +50% CHFCF_3 , boiling point: -48°C)

Other commonly used refrigerants:

- Ammonia
- Freon 12 (R-12)
- Freon 22 (R-22)
- Dry ice (CO₂)
- CFC (chlorofluorocarbon)
- HCFC(hydrochlorofluorocarbon)
- HFC (hydrofluorocarbon)

Properties of Refrigerant

Thermodynamics properties:

1. Boiling temperature- low as far as possible
2. Freezing temperature- high as far as possible
3. Compressor and evaporator pressure- it needs to be above atmospheric pressure. If it is not, it becomes difficult to detect the leakage.
4. Critical temperature and pressure- it should be high
5. COP & power

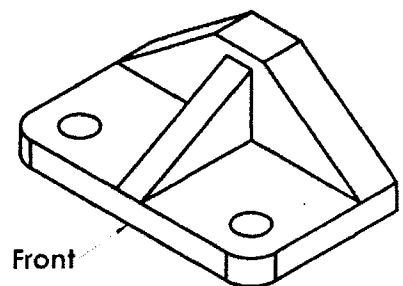
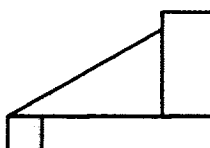
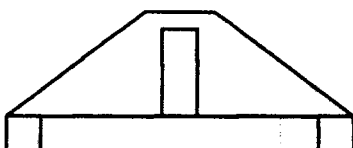
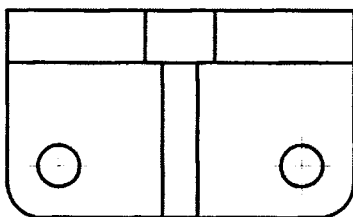
Chemical properties:

1. Flammability: Should be low.
2. Toxicity- Should be low.
3. Solubility with water- Should be low.
4. Miscibility- Ability to mix with oil is called miscibility

Physical properties:

1. Corrosive property
2. Viscosity
3. Leakage tendency
4. Inertness & stability
5. Thermal conductivity
6. Dielectric strength
7. Cost

12. Draw TOP, FRONT and SIDE view of the figure.



Rural Power Company Limited (RPCL)

Post: AE (Mechanical)

Time-03:30PM to 5:00PM

Date: 05.07.2019 Venue: MIST

Non Department 60 + Department 40

GK (20)+Bangla (5)+English (10), Analytical = 20 & Power sector related (5).

Departmental 8 questions

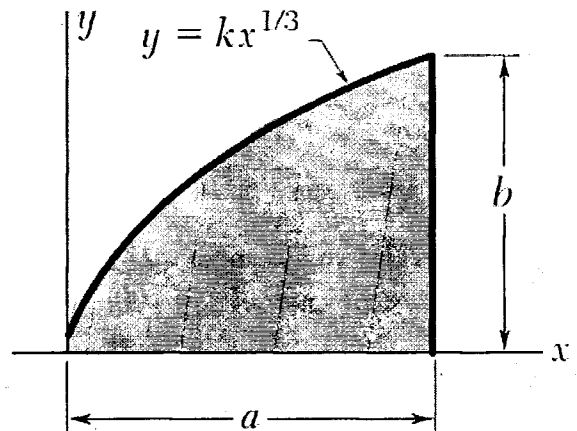
1. For a fully developed flow of water in a pipe having diameter 10 cm, velocity 0.1 m/s and kinematic viscosity $10^{-5} \text{ m}^2/\text{s}$, find out the value of Darcy friction factor?

Solution: Given, $D = 10 \text{ cm} = 0.1 \text{ m}$; $V = 0.1 \text{ m/s}$ and $\nu = 10^{-5} \text{ m}^2/\text{s}$

$$Re = \frac{VD}{\nu} = \frac{0.1 \times 0.1}{10^{-5}} = 1000, \text{ As } Re < 2300 \text{ so flow is laminar ;}$$

$$\therefore \text{Darcy friction factor, } f = \frac{64}{Re} = \frac{64}{1000} = 0.064 \text{ (Answer)}$$

2. Determine by direct integration the moment of inertia of the shaded area with respect to the y axis.



Solution:

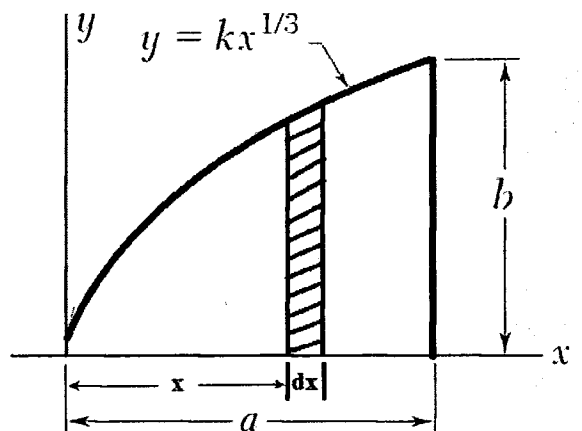
$$y = kx^{1/3} \text{ or, } b = ka^{1/3} \therefore k = \frac{b}{a^{1/3}}$$

$$\text{so, } y = \frac{b}{a^{1/3}} x^{1/3}$$

$$\text{Now, } dI_y = x^2 dA = x^2 y dx = x^2 \frac{b}{a^{1/3}} x^{1/3} dx$$

$$= \frac{b}{a^{1/3}} x^{7/3} dx$$

$$I_y = \int dI_y = \int_0^a \frac{b}{a^{1/3}} x^{7/3} dx = \frac{3}{10} a^3 b \text{ (Answer)}$$



3. A generating station has a connected load of 43MW and a maximum demand of 20 MW; the units generated being 61.5×10^6 per annum. Calculate (i) the demand factor and (ii) load factor.

Solution:

$$(i) \text{ Demand factor} = \frac{\text{maximum demand}}{\text{connected load}} = \frac{20}{43} = 0.465 \text{ or } 46.5\% \text{ (Answer)}$$

$$(ii) \text{ Average demand} = \frac{\text{Units generated/annum}}{\text{Hours in a year}} = \frac{61.5 \times 10^6}{8760} = 7020 \text{ KW}$$

$$\therefore \text{ Load factor} = \frac{\text{Average load}}{\text{Maximum demand}} = \frac{7020}{20 \times 10^3} = 0.351 \text{ or } 35.1\% \text{ (Answer)}$$

4. (a) Differentiate between energy and exergy.

Answer:

Energy	Exergy
1. Energy of a particular substance is the ability of that substance to do work.	1. Exergy is a thermodynamic term describing the maximum useful work that a substance can perform during the process of bringing a system into equilibrium with a heat reservoir.
2. Energy of a substance refers to the work it can perform.	2. Exergy of a substance refers to the maximum work that it can perform.
3. Energy is a quantitative measurement.	3. Exergy is a qualitative measurement.
4. We can't destroy energy.	4. Exergy can be destroyed during the process.
5. Energy of a substance does not depend on its environment.	5. We always define exergy related to its environment.

(b) Define: Prandtl Number and Euler Number

Prandtl Number: The Prandtl Number is a dimensionless number approximating the ratio of momentum diffusivity (kinematic viscosity) to thermal diffusivity and can be expressed as

$$Pr = \frac{\nu}{\alpha}$$

Where,

Pr = Prandtl's number; ν = momentum diffusivity (m^2/s) and α = thermal diffusivity (m^2/s)

The Prandtl number can alternatively be expressed as

$$Pr = \frac{\mu C_p}{k}$$

Where, μ = absolute or dynamic viscosity (kg/m-s , $\text{lb}_m/(\text{ft h})$)

c_p = specific heat (J/kg K , $\text{Btu}/(\text{lb}_m \text{ } ^\circ\text{F})$)

k = thermal conductivity (W/m K , $\text{Btu}/(\text{h ft}^2 \text{ } ^\circ\text{F/ft})$)

Euler Number: The Euler Number is a dimensionless value used for analyzing fluid flow dynamics problems where the pressure difference between two points is important. The Euler Number can be interpreted as a measure of the ratio of the pressure forces to the inertial forces.

The Euler Number can be expressed as

$$Eu = \frac{P}{\rho V^2}$$

Where,

Eu = Euler number, P = pressure (Pa), ρ = density (kg/m^3) and v = fluid flow velocity (m/s)

The pressure difference is often used

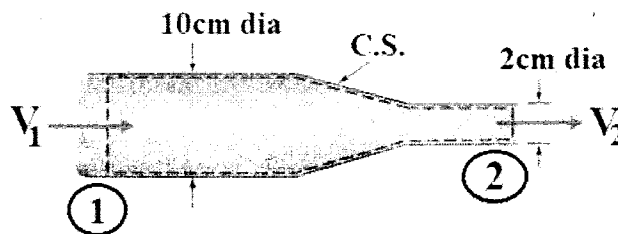
$$Eu = \frac{dP}{\rho V^2}$$

Where, dp = differential pressure (Pa)

5. Draw the schematic diagram of a vapor compression refrigeration cycle.

Answer: Same as Question No. 14, North West Power Generation Company Limited (NWPGL)-2015

6. Water flows at a uniform velocity of 3 m/s into a nozzle that reduces the diameter from 10 to 2 cm. Calculate the water's velocity leaving the nozzle and the flow rate Q. Assume constant density and uniform velocity distributions.



Solution:

We get, $A_1 V_1 = A_2 V_2$

$$\therefore V_2 = \frac{A_1}{A_2} \times V_1 = \frac{\frac{\pi}{4} \times 0.1^2}{\frac{\pi}{4} \times 0.02^2} \times 3 = 75 \text{ m/s (Answer)}$$

$$Q = \frac{\pi}{4} \times 0.02^2 \times 75 = 0.02356 \text{ m}^3/\text{s (Answer)}$$

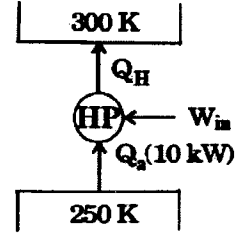
7. A heat pump absorbs 10 kW of heat from outside environment at 250K while absorbing 15 kW of work. It delivers the heat to a room that must be kept warm at 300 K. What is the Coefficient of Performance (COP) of the heat pump?

Solution:

Here,

Heat absorbed from outside (Q_a) = 10 kWWork performed (W_{in}) = 15 kWTotal heat delivered (Q_H) = 10 + 15 = 25 kWCoefficient of performance (CoP) = $\frac{Q_H}{W_{in}}$

$$= \frac{25}{15} = 1.67 \text{ (Answer)}$$



8. A circular solid disc of uniform thickness 20 mm, radius 200 mm and mass 20 kg, is used as a flywheel. If it rotates at 600 rpm, find the kinetic energy of the flywheel.

Solution:For solid disk of uniform thickness, $I = \frac{1}{2}mr^2$

$$\therefore \text{Kinetic energy, K.E} = \frac{1}{2}I\omega^2 = \frac{1}{2} \times \frac{1}{2}mr^2 \times \left(\frac{2\pi N}{60}\right)^2 = \frac{1}{2} \times 0.5 \times 20 \times 0.2^2 \times \left(\frac{2\pi \times 600}{60}\right)^2$$

$$= 789.56 \text{ Joules (Answer)}$$

[For wheel loaded at rim, $I = mr^2$, For solid disk of uniform thickness, $I = \frac{1}{2}mr^2$, For solid sphere, $I = \frac{2}{5}mr^2$, For spherical shell, $I = \frac{2}{3}mr^2$ and for rectangular rod, $I = 0.5mr^2$]

বাংলাদেশ মৎস্য উন্নয়ন কর্পোরেশন
জনবল নিয়োগের লিখিত পরীক্ষা-২০১৯

পদের নামঃ প্রকৌশলী (মেকানিক্যাল)
পূর্ণমানঃ ৮০

সময়ঃ ১ঘন্টা ৩০ মিনিট।

ক-বিভাগ
(আবশ্যিকভাবে উত্তর দিতে হবে)

মান-৩০

১. “বৈজ্ঞানিক পদ্ধতিতে মাছ চাষ” সম্পর্কে অনুচ্ছেদ লিখুন।

৫

২. মূলভাব লিখুনঃ

৫

সত্য ওজন দরে বা গজের মাপে বিক্রয় করা হয় না। তাহা ছোট হইলেও বড়। পর্বত পরিমাণ খড়বিচালি ফলিঙ্গ পরিমাণ আগুনের চেয়ে বড় কিন্তু আসলে বড় নহে। সমস্ত সেজের মধ্যে যেখানে সলিতার সূচত্র পরিমাণ মুখটিতে আলো জ্বলিতেছে সেখানেই সমস্ত সেজটার সার্থকতা। তেলের নিম্নভাগে অনেকখানি জল আছে, তাহার পরিমাণ যতই হোক, সেটাকে আসল জিনিস বলিবার কোন হেতু নাই। সমস্ত সমাজই সমাজ প্রদীপের আলোটুকু যাঁহারা জ্বালাইয়াছে, তাঁহারা সংখ্যা হিসাবে নগণ্য, সভ্য হিসাবে তাঁহারা সমাজে অগ্রগণ্য। তাঁহারা দক্ষ হইতেছেন, আপনাকে তাঁহারা নিমেষে ত্যাগ করিতেছেন, তবু তাঁরাই দীপ্যমান।

৩. Write a paragraph on "city life in Dhaka"

৫

৪. ইংরেজিতে অনুবাদ করুনঃ

৫

নয়নিষ্ঠা অনুশীলন করতে হবে এবং একে অভ্যাসে পরিনত করে তুলতে হবে। এই গুণকে বাল্যকাল থেকেই আমাদের

সমস্ত কাজের মধ্য দিয়ে অর্জন করতে হবে। বাল্যকাল হচ্ছে বীজ বপনের সময়। এই সময়ে গড়ে ওঠা অভ্যাস আমাদের সমস্ত জীবন ধরেই চলবে। 'ঠিক সময়ে ঠিক কাজ' আমাদের মূলনীতি হওয়া উচিত।

৫. বাংলাদেশ হতে কোন কোন দেশে মাছ রপ্তানি করা হয়? ১
৬. বিশ্বকাপ ক্রিকেট ২০১৯ এ বোলার হিসেবে হ্যাটট্রিক করার রেকর্ড কোন কোন খেলোয়াড়ের? ১
৭. কোন সালের কত তারিখে মুজিব নগরে বাংলাদেশের অস্থায়ী সরকার শপথ গ্রহণ করেন? ১
৮. কেন্দ্রীয় শহীদ মিনারের স্থপতি কে? ১
৯. বঙ্গবন্ধুর অসমাপ্ত আত্মজীবনী কবে প্রকাশিত হয়? ১
১০. GMT কী? ১
১১. বাংলাদেশের সবচেয়ে বড় প্রাকৃতিক মৎস প্রজনন কেন্দ্র কোনটি? ১
১২. সুন্দরবন বাংলাদেশের কোন কোন জেলা নিয়ে অবস্থিত? ১
১৩. UNICEF এর পূর্ণরূপ? ১
১৪. জাতীয় সংসদে ২০১৯-২০ অর্থ বছরে কত টাকার বাজেট উপস্থাপন করা হয়েছে? ১

খ-বিভাগ

মান-৫০

(প্রযোজ্য ক্ষেত্রে যেকোন একটি ডিসিপ্লিনের উত্তর দিন)
মেকানিক্যাল

১. থার্মোডাইনামিক্স (Thermodynamics) এর কয়টি সূত্র (Law) আছে? সূত্র (Law) গুলো লিখুন? ৫
২. এক্সটেনসিভ (Intensive) এবং ইন্টেনসিভ (Extensive) প্রোপার্টি (Property) বলতে কি বুঝায়? ৫
৩. বয়লার (Boiler) কি? বয়লার (Boiler) মাউন্টিংস (Mounting) এবং এক্সেসরিজ (Accessories) বলতে কি বুঝায়? উদাহরণসহ লিখুন? ৫
৪. কার্নোট (Carnot) সাইকেল (Cycle) কে প্রাকটিক্যালি (Practically) নন ভায়াবল (Non-viable) সাইকেল (Cycle) বলা হয় কেন লিখুন? ৫
৫. সান্দ্রতা (Viscosity) কি? তাপমাত্রার সাথে সান্দ্রতার সম্পর্ক লিখুন? ৫
৬. ল্যামিনার (Laminar) ও টার্বুলেন্ট (Turbulent) ফ্লো এর মধ্যে প্রধান পার্থক্যগুলো লিখুন? ৫
৭. টন অফ রেফ্রিজারেশন (Ton of refrigeration) বলতে কি বুঝায়? একটি ভালো রেফ্রিজারেন্ট (Refrigerant) এর প্রধান বৈশিষ্ট্যগুলো লিখুন। ৫
৮. COP (Co-efficient of Performance) কি? রেফ্রিজারেটর (Refrigerator) ও হিট পাম্প (Heat Pump) এর প্রধান পার্থক্য লিখুন। ৫
৯. ইঞ্জিন (Engine) ও মেশিনের (Machine) মধ্যে পার্থক্য কি? ডিজেল ও পেট্রোল ইঞ্জিনের পার্থক্যগুলো কি কি? ৫
১০. কাটিং ফ্লুইড (Cutting Fluid) এর কাজ কি? কাটিং টুল (Cutting Tool) ও কাটিং ফ্লুইড (Cutting Fluid) এর প্রধান বৈশিষ্ট্য লিখুন? ৫

Bangladesh Fisheries Development Corporation (BFDC)-2017

1) Draw a typical stress-strain diagram for mild steel showing yield strength, ultimate strength & breaking strength.

Answer: Same as Question -1 Power Development Board (PDB)-2010

2) What is coefficient of contraction, coefficient of velocity & coefficient of discharge.

$$\text{Co-efficient of Velocity } (C_v) = \frac{\text{Actual velocity of jet at vena contracta } (V)}{\text{Theoretical Velocity } (\sqrt{2gh})}$$

$$= [0.95 \sim 0.99]$$

$$\text{Co-efficient of Contraction (C}_c\text{)} = \frac{\text{Area of jet at vena contracta, } a_c}{\text{Area of orifice, } a} = [0.61 \sim 0.69]$$

$$\text{Co-efficient of discharge (C}_d\text{)} = \frac{\text{Actual discharge of an orifice, } Q}{\text{Theoretical discharge of an orifice, } Q_{th}} = [0.61 \sim 0.65]$$

3) write the difference of water tube & fire tube boiler. write some selection conditions for boiler.

Answer: Question-03 West Zone Power Distribution Company Ltd. (WZPDCL)-2016 and question-1 Bangladesh Bank (Assistant Director-ME)-2019

4) Draw a cantilever beam of 2m long. 1KN force acting in the free end. 2KN force acting 1m from free end. Draw shear force and bending moment diagram.

Answer: Question 20 Electricity Generation Company of Bangladesh (EGCB)

5) Write the name of efficiencies of centrifugal pump. Draw a performance characteristics curves for a centrifugal pump.

6) Write some name of commonly used refrigerants. Write some difference of refrigerator and heat pump.

Answer: Question-1 Bangladesh Bank (Assistant Director-ME)-2019

7) Draw TOP and Front view.

Answer: Same as question Eastern Refinery Limited (ERL)-2017

8) Maisa is building a pyramid with some cans. she give 1 can at first row. she add 6 cans in every row and build 16 rows. how many cans she need to build the pyramids.

9) To produce a particular radio model it costs a manufacturer \$30 per radio. and it is assumed that if 500 radios are produced all of them will be sold. what must be the selling price per radio to ensure that the profit for 500 radios is greater than \$8200??

10) Write an essay "Development of Bangladesh: Challenges and prospects"

11) Write an essay "পরিবেশ বিপর্যয়"।

Ashuganj Power Station Company Limited (APSCL)

Post: AE (Mechanical)

Time-10.00AM to 11.30 AM

Date: 05.07.2019 Venue: BUET

GK+Bangla+English= 60×0.5=30; Analytical = 15×1=15

Departmental = 11×5=55

Non-Departmental

1. Aylan Kurdi's body was discovered at _.

Answer: Mediterranean Sea

2. Which is the third sea port of Bangladesh?

Answer: Port of Payra

3. What is the name of Russian currency?

Answer: Ruble

4. Who is the United States Secretary of State?

Answer: Mike Pompeo

5. When Dhaka was declared as the capital first?

Answer: 1610

6. When the Father of the Nation Bangabandhu Sheikh Mujibur Rahman was returned to Bangladesh after Liberation War?

Answer: January 10, 1972

7. Which sector was under Naval commandos during 1971?

Answer: Sector 10

8. When was Lahore resolution passed?

Answer: 1940

9. Which party elected at 1954 election?

Answer: United Front

10. The only foreigner received the 'Bir Protik' award was born at-

Answer: Netherlands

11. What is the position of Bangladesh at UN peacekeeping Mission as a contributor of troops? **Answer:** Second

12. Which city is between two continents? **Answer:** Istanbul

13. How many Indian states share a border with Bangladesh? **Answer:** 5

14. Headquarter of which organization is in Dhaka? **Answer:** BIMSTEC

15. During partition of Bengal who was the viceroy of eastern Bengal?

Answer: Lord Curzon

16. National tree of Bangladesh? **Answer:** Mango

17. What is E-8?-

18. Which security System was compromised during hacking of Bangladesh Bank?- **SWIFT code**

19. The object is _____ heavy for him to lift. (a) too (b) so

20. Take revenge ___ you. (a) on

21. Absent ___ the meeting (a) from

22. Antonym of 'Lend'. **Answer:** Borrow

23. Antonym of 'Transparent'. **Answer:** Opaque

24. There is no alternative _ training. **Answer:** to

25. Synonym of 'Stringent'- **Rigorous**

26. Increase in humidity in air results in what change in sound velocity?- **Increases**

27. Amount of National Budget for 2019-20 of Bangladesh?- **Tk. 5.23 Trillion (Tk5,23,190 crore)**

28. In the proposed budget, the GDP growth is projected at- **8.2%**

29. What type of Power Plant is APSCL? – **Thermal**

30. Where APSCL is planning to establish new power plant? – **Patuakhali (1320 MW Super Thermal Power Plant Project)**

31. Present capacity of APSCL? – **1627 MW (Net output) [Installed Capacity 1876 MW]**

32. Largest solar power plant of Bangladesh? – **Teknaf's Hnila**

33. 50% of power comes from- (a) Coal (b) **Gas** (c) HFO

34. 20% of power comes from- (a) Coal (b) **Gas** (c) HFO

35. 3% of power comes from- **Hydro**

36. Govt. and private sector power generation percentage- **55:45** (Answer not sure)

Source for 33,34 & 35

http://www.bpdb.gov.bd/bpdb_new/index.php/site/power_generation_unit

৩৭. 'তুমি আসবে বলে হে স্বাধীনতা' - লেখাটি কার? - **শামসুর রাহমান**

৩৮. 'মধুবালা' কি? - **সাদা জাতের তরমুজ**।

৩৯. 'চোখের পর্দা' বাগধারাটির অর্থ কি? - **লজ্জা**

৪০. 'তার কবি কবি ভাব'-এখানে 'কবি কবি' কোন পদ? - **বিশেষণ**

৪১. কবি কাজী নজরুল ইসলাম কোন কাব্যটি রবীন্দ্রনাথকে উৎসর্গ করেছিলেন? - **সম্মতি**

৪২. ইন্দো আরবিয়ানদের আদি বাস কোথায় ছিল? - **ইউরাল পর্বতের দক্ষিণে তৃণমূল অঞ্চলে**

Analytical

43. The age of A is 5 years less than B. Age of B is 3 times than that of C. If 4 years ago, age of C is 10 years, what will be the age of A after 6 years?

Answer: 43years

44. A woman walking with a boy meets another woman and on being asked about her relationship with the boy, she says, "My maternal uncle and his maternal uncle's maternal uncle are brothers." How is the boy related to the woman?

(a) Nephew (b) Brother-in-law (c) **Son** (d) Grandson

45. A & B can complete a work within 4 days, A alone can complete that work within 12 days, B & C can complete that work within 6 days. Within how many days A & B & C complete that work jointly.

Answer: [Data may be varied]

46. Out of 20 questions, one wrong answer deduct 2 marks & one right answer add 5 marks, if someone scored 72, how many questions he answered rightly.

Answer: 16

47. In a room there are some birds and cats. There are total 50 legs and 15 heads in that room. How many cats were there? **Answer: 10**

48. 29th February 2016 Rahim celebrated his 15th birthday. In which year he was born.

Answer: 2000

49. Out of 20 questions, one wrong answer deduct 2 marks & one right answer add 5 marks, if someone scored 72, how many questions he answered rightly.

Answer: 16 $(16 \times 5 - 4 \times 2) = 72$

50. The difference of the square of two consecutive odd numbers is 96. What is the sum of these two numbers? **Answer:** 48. $(25^2 - 23^2)$

51. A number 8567mn is divisible by 80, what is the lowest number for m+n?

52. A workman starts his work on Monday works for 8 days and takes every 9th day as his holiday. His 12th holiday will fall on? **Answer:** Wednesday

Departmental

1. An ice machine working on vapor compression refrigeration cycle produces 10 Kg/hr ice from 30°C to -5°C, specific heat of ice 2.1KJ/Kg.K and water 4.2KJ/Kg.K. Latent heat 344 KJ/Kg. Find out refrigeration capacity. If compressor work is taken 0.3KW then find, COP.

$$\begin{aligned} \text{Solution: Refrigeration Capacity} &= \frac{mS_w\Delta\theta}{60} + \frac{ml_f}{60} + \frac{mS_i\Delta\theta}{60} \text{ KJ/min} \\ &= \frac{10 \times 4.2 \times (30-0)}{60} + \frac{10 \times 344}{60} + \frac{10 \times 2.1 \times (0+5)}{60} \\ &= 80.08 \text{ KJ/min} = 0.38 \text{ Ton (Answer)} \end{aligned}$$

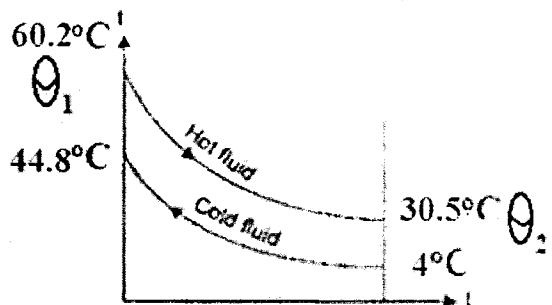
$$\text{COP} = \frac{\text{Refrigeration Capacity in KW}}{\text{Compressor Work}} = \frac{0.38 \times 3.5}{0.3} = 4.43 \text{ (Answer)}$$

2. Counter flow shell tube heat exchanger cools water from 60.2°C to 30.5°C by ethylene glycol at 4°C. Specific heat of water is 4200 J/KgK and ethylene glycol 3330J/Kg.K. Mass flow rate of ethylene 5.6Kg/s. Mass flow rate of water 6.1 Kg/s. find out LMTD.

$$\begin{aligned} \text{Solution: We get, } \dot{m}_h c_{ph} \times (t_{h1} - t_{h2}) &= \dot{m}_c c_{pc} \times (t_{c2} - t_{c1}) \\ \text{or, } 6.1 \times 4200 \times (60.2 - 30.5) &= 5.6 \times 3330 \times (t_{c2} - 4) \\ \therefore t_{c2} &= 44.8^\circ\text{C} \end{aligned}$$

Log mean temperature difference,

$$\begin{aligned} \text{LMTD, } \theta_m &= \frac{\theta_1 - \theta_2}{\ln(\theta_1/\theta_2)} \\ &= \frac{(t_{h1} - t_{c1}) - (t_{h2} - t_{c2})}{\ln\left(\frac{t_{h1} - t_{c1}}{t_{h2} - t_{c2}}\right)} \\ &= \frac{(60.2 - 44.8) - (30.5 - 4)}{\ln\left(\frac{60.2 - 44.8}{30.5 - 4}\right)} \\ &= 20.45^\circ\text{C (Answer)} \end{aligned}$$



3. In a power plant water tube boiler is used to produce steam at 1 ton/hr. Fuel burns 50Kg/hr. Specific enthalpy of steam 2700KJ/Kg and specific enthalpy of water 210KJ/Kg. Heating value of fuel is 85000KJ/KJ. What is the efficiency of boiler?

Solution: Boiler Efficiency $= \frac{m_s(h-h_{fw})}{m_f \times C} = \frac{1000(2700-210)}{50 \times 85000}$
 $= 0.5858 \approx 58.58\%$ (Answer)

4. In air standard Brayton cycle air enters compressor at 0.5MPa at 15°C and exit 1.5MPa. Maximum temperature is 1000°C. Compressor efficiency 85%, $\gamma=1.4$; $C_p = 1.004\text{KJ/Kg}$, $C_v = 0.717\text{KJ/Kg}$. Find out compressor work.

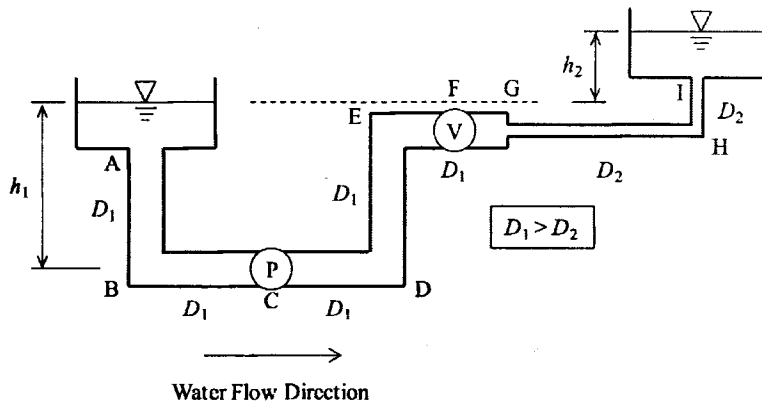
Solution: We get, $\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$

$\Rightarrow T_2 = T_1 \times \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} = 288 \times \left(\frac{1.5}{0.5}\right)^{\frac{1.4-1}{1.4}} = 394.2\text{K}$

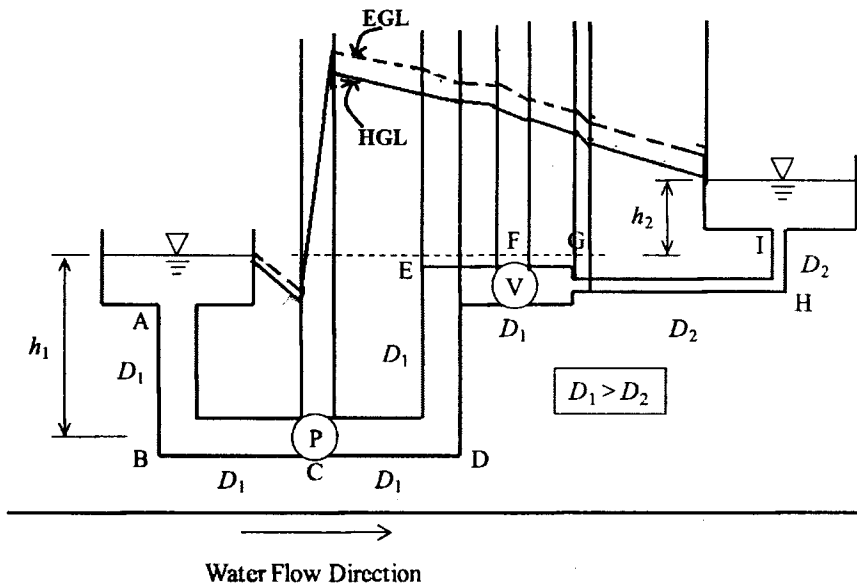
\therefore Ideal compressor workdone $= C_p \times (T_2 - T_1) = 1.004 \times (394.2 - 288) = 106.62 \text{ KJ/Kg}$

\therefore Actual Compressor workdone $= \frac{106.62}{0.85} = 125.44\text{KJ/Kg}$ (Answer)

5. Sketch and label the Energy Grade Line (EGL) and Hydraulic Grade Line (HGL).



Solution:



6. A submersible pump has a head of 40.5m, discharge of 25L/s. Rating for running of the pump is: 3 ϕ AC supply, 22A, 400V, pf 0.95, Find efficiency of the submersible pump.

Solution: Given that, $H = 40.5\text{m}$, $Q = 25\text{L/s} = 0.025\text{ m}^3/\text{s}$, $I = 22\text{ A}$, Voltage, $V = 400\text{ V}$,
 $\text{pf} = \cos \theta = 0.95$

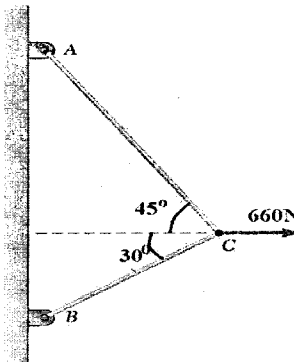
Pump input power, $P = \sqrt{3}VI \cos \theta = \sqrt{3} \times 400 \times 22 \times 0.95 = 14479.94\text{W}$

$$\therefore \text{Efficiency, } \eta = \frac{\gamma HQ}{P}$$

$$= \frac{9.81 \times 100 \times 40.5 \times 0.025}{14479.94}$$

$$= 68.59\% \text{ (Answer)}$$

7. Two cables are tied together at C and are loaded as shown. Determine the tension (a) in cable AC, (b) in cable BC.



Solution:

According to Lami's Theorem at point C,

$$\frac{660}{\sin 75^\circ} = \frac{T_{AC}}{\sin 150^\circ} = \frac{T_{BC}}{\sin 135^\circ}$$

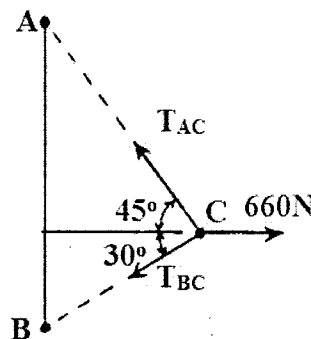
$$\therefore T_{AC} = \frac{660}{\sin 75^\circ} \times \sin 150^\circ =$$

341.64N (Answer)

$$\therefore T_{BC} = \frac{660}{\sin 75^\circ} \times \sin 135^\circ =$$

483.15N (Answer)

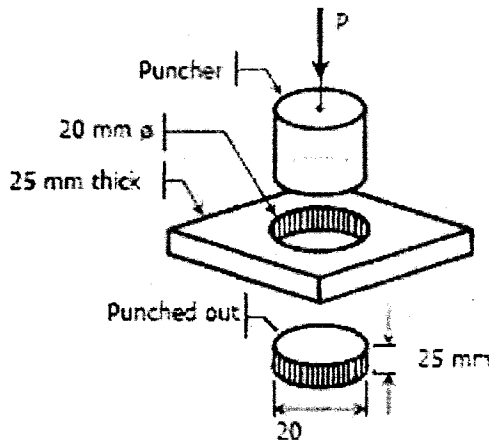
Free-Body Diagram



8. Find out maximum allowable tensile load be for buckling for 30mm diameter column, effective length 1.5m. Young modulus $E=105\text{GPa}$.

Solution: We get, $P = \frac{EI\pi^2}{L_e^2} = \frac{E \times \frac{\pi}{64} D^4 \times \pi^2}{L_e^2} = \frac{105 \times 10^9 \times \frac{\pi}{64} \times (0.03)^4 \times \pi^2}{1.5^2} = 18313.08\text{ N (Answer)}$

9. What force is required to punch a 20-mm-diameter hole in a plate that is 25 mm thick? The shear strength is 350 MN/m^2 .

**Solution:**

The resisting area is the shaded area along the perimeter and the shear force V is the equal to punching force P .

$$V = \tau A$$

$$\begin{aligned} P &= 350 \times (\pi(0.02) \times (0.025)) \\ &= .54978 \text{ MN} \\ &= 549.8 \text{ kN} \end{aligned}$$

10. A 60 mm diameter shaft running in a bearing carries a load of 2000 N. If the coefficient of friction between the shaft and bearing is 0.03, find the power transmitted when it runs at 1440 r.p.m.

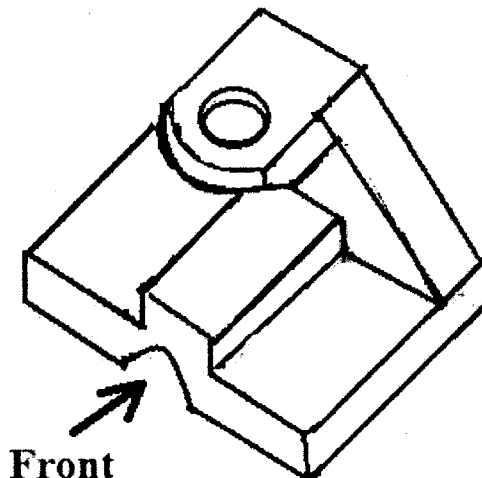
Solution: Given : $d = 60 \text{ mm}$ or $r = 30 \text{ mm} = 0.03 \text{ m}$; $W = 2000 \text{ N}$; $\mu = 0.03$; $N = 1440 \text{ r.p.m.}$

$$\Rightarrow \omega = 2\pi \times \frac{1440}{60} = 150.8 \text{ rad/s}$$

We know that torque transmitted,

$$P = T \omega = \mu \times W \times r \times \omega = 0.03 \times 2000 \times 0.03 \times 150.8 = 271.44 \text{ W (Answer)}$$

11. Draw the Front and Right Side section view of the following figure. [similar image]



Bangladesh Chemical Industries Corporation (BCIC)**Post: AE (Mechanical)****Time-10.00AM to 11.30 AM****Date: 19.07.2019 Venue: BUET****GK+Bangla+English= 60×0.5=30; Analytical = 10×1=10****Non-departmental**

1. Which country is the current champion of FIFA World Cup?
(a) Croatia (b) Argentina (c) Brazil (d) France
2. A chronometer measures:
(a) Colour contrast (b) Sound waves (c) Time (d) Water waves
3. AIDS is related to- (a) **Virus**
4. The headquarters of U.N. is located in- a) Rome b) Geneva c) **New York** d) Washington D.C
5. Which European country first recognized Bangladesh as a sovereign state?
a. Albania b. **East Germany** c. Poland d. Romania
- অনেক বইতে উত্তর **পোলান্ড** দেওয়া আছে। সুতরাং উত্তর আপনি কোনটা দিবেন এটি আপনার বিবেচনা।
6. Where the US defense headquarter is located?- **Pentagon (Virginia)**
7. Which is true for dengue? (a) Urban (b) less plate (c) virus (c) **all of these**
8. Who got Noble peace prize: (a) Yasser Arafat (b) Barack Obama (c) (d) **all of them**
9. Which Bengali got the first Oscar? -**Nafees Bin Zafar**
10. During liberation war Bangladesh was divided into _ sectors. – **11**
11. Which country owns Al Jazeera?- **Qatar**
12. The number of already named bones in the human skeleton is-. **206**
13. What is the average life expectancy in Bangladesh?- **72.4 or 73**
14. Where the only LNG Terminal of Bangladesh is located? - **Moheshkhali**
15. Which one of the following gases is a greenhouse gas?
(a) methane (b) NO₂ (c) carbon dioxide (d) **all of the above.**
16. Which material is urban contamination of air? **Lead**
17. When the constitution of republic of Bangladesh was accepted? **1972**
18. Mujibnagar situated at-- a) Chuadanga b) Nababganj c) Satkhira d) **Meherpur**
19. The only Coral Island of Bangladesh is - **St. Martin**
20. Commercial aircraft typically fly at an altitude of- **36,000 feet**
21. LPG consists of mainly: **Butane and Propane**
22. Which is the largest district in Bangladesh?- **Rangamati**
23. Karnafuli Paper Mills raw material is- **Bamboo**
24. The number of international airports in Bangladesh is-- a) one b) two c) **three** d) four
25. Which material used for transistor? - **Silicon**
26. Halley's comet appears once in a period of- **76 years**

27. Who was the first Secretary-General of SAARC? - **Abul Ahsan**

28. The Roman Magsaysay was in the name of former president in which country? - **Philippines**

29. Enzymes are? (a) **Proteins** (b) Carbohydrates (c) Fats (d) None of the above

30. Correct spelling: **guarantee**

31. Correct spelling: **decision**

32. Preposition: I will take revenge --- you. - **on**

33. He stands (before) me. "before" used as? **Preposition**

34. Noun form of Cook? **Cook**

35. We need two hundred dollars__this to pay for everything. a. as well b. also beside d. **besides**

36. Best opposite word of Common: **rare**

37. Same meanings of Amicable: **friendly**

38. The word "lucrative" means-- a) **profitable** b) oil c) professional d) good

39. জীব প্রেম করে যেই জন, সেই জন সেবিছে ঈশ্বর।'- উক্তিটির রচয়িতা কে? - **স্বামী বিবেকানন্দ**

40. মতৈক্য সন্ধি বিচ্ছেদ কোনটি? - **মত+ ঐক্য**

41. সমাসের শাব্দিক অর্থ - **মিলন** (জানা ভালোঃ সমাস মানে সংক্ষেপ, মিলন বা একাধিক পদের একপদীকরণ)

42. অন্ধজনে দেহ আলো।- এখানে 'আলো' শব্দটি কোন কারক? - **কর্ম কারক**

43. কোন বাক্যটি বিশেষ বহুবচনে গঠিত: (a) সকল মানুষই মরণশীল (b) বাজারে লোক জমেছে

44. কোনটি ভুল: (a) **ত্রিগুন** (b) পিণাক (c) দুর্নীতি (d) ব্রাহ্মণ

45. কোনটি দেশী শব্দ: **ডিঙা**

46. কোনটি খাঁটি বাংলা উপসর্গ: (a) রাম (b) কদ (c) কু (d) **সবগুলো**

47. বাংলা গদ্যে চলিত রীতির প্রবর্তক কে? - **প্রমথ চৌধুরী**

48. ধ্বনি বিপর্যয় হয়েছে কোনটিতে? ধ্বনি বিপর্যয় - এর উদাহরণ কোনটি?

(a) মুড়া > মুড়ো (b) **বাকস > বাসক** (c) মোজা > মুজো (d) দেশি > দিশি

49. আকাশ শব্দের বিপরীতার্থক শব্দ কোনটি? **পাতাল**

Analytical

50. If $x + \frac{1}{x} = 3$ then what is the value of $x^2 + \frac{1}{x^2} = ?$ **Answer: 7**

51. When $f(x) = \frac{x+2}{x-2}$ and $x \neq 2$, find the maximum value for the function. a. -1 b. 0 c. 3 d.

52. $2^{30} + 2^{30} + 2^{30} + 2^{30} = ?$ **Answer: 2^{32}**

53. If $\log_x \frac{1}{8} = -\frac{3}{2}$ then the value of $x = ?$ **Answer: 4**

54. In a class of 78 students 41 are taking French, 22 are taking German. Of the students taking French or German, 9 are taking both courses. How many students are not enrolled in either course?

(a) 6 (b) 12 (c) **24** (d) 18

55. What is $\sqrt{5}$ percent of $5\sqrt{5}$? **Answer: 0.25**

56. What is the relationship between $ax+by = c$ and $bx -ay = c$ if a,b,c are not zero? Answer: **Perpendicular.**

57. Poly was P times older than Ben 6 years ago. If Poly is now 17, then what is Ben's age now in terms of P . **Answer: $11/P+6$**

58. If $\log_4 = 12$, then $\log_2 (x/4)$ is equal to- **22**

বাকিগুলো সংগ্রহ করা সম্ভব হয়নি।

1. Water is flowing from a large reservoir of 40m head in a hydroelectric power plant through a turbine. If a horizontal thrust of 1kN is developed in fixed vane, find the power developed by turbine. The diameter of the exit pipe of the reservoir is 150mm.

Solution:

We get,

$$\text{Horizontal thrust} = \rho A V^2 = 1\text{kN} = 1000\text{N}$$

$$\Rightarrow V^2 = \frac{1000}{1000 \times \frac{\pi}{4} \times D^2} = 56.58$$

$$\Rightarrow V = 7.52 \text{ m/s}$$

According to Bernoulli's Equation,

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 + H_T$$

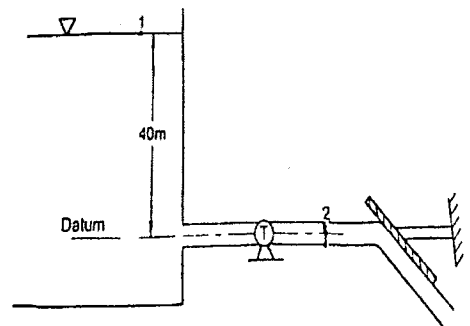
$$\Rightarrow 0 + 0 + Z_1 = 0 + \frac{V_2^2}{2g} + 0 + H_T$$

$$\Rightarrow 40 = \frac{(7.52)^2}{2 \times 9.81} + H_T$$

$$\Rightarrow H_T = 37.12 \text{ m}$$

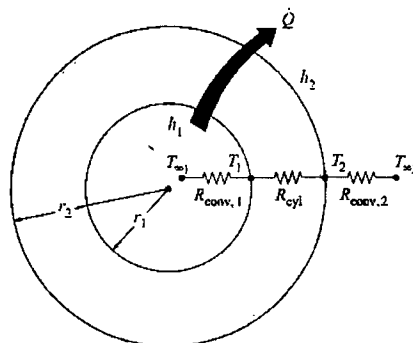
$$\therefore \text{Power} = \rho g A V H_T = 1000 \times 9.81 \times \frac{\pi}{4} \times 0.15^2 \times 7.52 \times 37.12$$

$$= 48391.3\text{W} = 48.40\text{KW (Answer)}$$



2. A pipe has inner and outer radius of r_i & r_o and a fluid is passing through it with heat transfer co-efficient h_i , Surrounding air heat transfer co-efficient is h_o , thermal conductivity and length of pipe is K and L , If area is A then draw the thermal resistance network and write down the equation of heat loss.

Solution:



$$R_{\text{total}} = R_{\text{conv},1} + R_{\text{cyl}} + R_{\text{conv},2}$$

$$= \frac{1}{(2\pi r_1 L)h_1} + \frac{\ln(\frac{r_2}{r_1})}{2\pi Lk} + \frac{1}{(2\pi r_2 L)h_2}$$

$$Q = \frac{T_{\alpha 1} - T_{\alpha 2}}{R_{\text{total}}}$$

3. A centrifugal pump delivers $0.04 \text{ m}^3/\text{s}$ of water to a height of 14m through a 15cm diameter pipe and 25m long. The overall efficiency of pump is 62.5%. Find the power required to drive the pump. Take friction factor co-efficient, $f=0.045$.

Solution:

$$\text{We get, } V_s = V_d = V = \frac{Q}{A} = \frac{0.04}{\frac{\pi}{4} \times (0.15)^2} = 2.26 \text{ m/s} \quad \eta_0 = 0.625$$

$$\therefore H_m = (h_s + H_d) + (h_{fs} + h_{fd}) + \frac{v_d^2}{2g}$$

$$= H + \frac{\rho v^2}{2gd} + \frac{v_d^2}{2g} = 14 + \frac{0.045 \times 25 \times (2.26)^2}{2 \times 9.81 \times 0.15} + \frac{(2.26)^2}{2 \times 9.81} = 16.21 \text{ m}$$

$$\therefore P = \frac{\rho g Q H_m}{\eta} = \frac{9810 \times 0.04 \times 16.21}{0.625} = 10.18 \text{ KW (Answer)}$$

4. A thin walled steel boiler has a mean radius of 40mm and its thickness is 2mm, assuming the internal pressure is 25MPa, find out the (i) longitudinal stress, (ii) hoop stress and (iii) the maximum shear stress.

Solution: Given, $D = 80 \text{ mm}$; $t = 2 \text{ mm}$; $P = 25 \text{ MPa}$; $\sigma_t = ?$ $\sigma_l = ?$

Here, Longitudinal stress, $\sigma_L = \frac{PD}{4t}$

$$\sigma_1 = \frac{25 \times 80}{4 \times 2} = 250 \text{ MPa (Answer)}$$

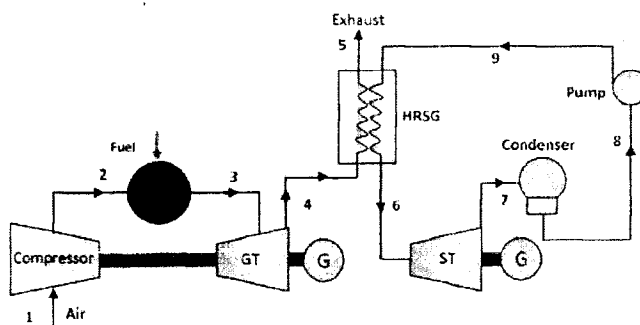
Tangential stress, $\sigma_t = \frac{PD}{2t}$

$$\sigma_t = \frac{25 \times 80}{2 \times 2} = 500 \text{ MPa (Answer)}$$

Maximum shear stress, $\tau_{\max} = \frac{\sigma_t - \sigma_l}{2} = \frac{500 - 250}{2} = 125 \text{ MPa}$ (Answer)

- 5. Draw the schematic of combined cycle power plant. Also showing the flow direction of working fluid and mention the important components.**

Answer:



6. A shaft carries bearing load at its one end fixed. The shaft is 1m long and the other end carries a disc of mass 1kg at a radius of gyration of 0.8 m. Torsional stiffness of the shaft is 10^4 Nm/radian. Determine the mass moment of inertia and natural frequency of the shaft.

Solution:

We know that mass moment of inertia of the shaft,

$$I = m.k^2 = 1 \times (0.8)^2 = 0.64 \text{ kg-m}^2 \text{ (Answer)}$$

Frequency of torsional vibrations,

$$F_n = \frac{1}{2\pi} \sqrt{\frac{q}{I}} = \frac{1}{2\pi} \sqrt{\frac{10^4}{0.64}} = 19.9 \text{ Hz (Answer)}$$

7. A steel casting cools to 95 percent of the original temperature difference in 40 min in still air. How much time it should require to cool this same casting to 95 percent of the original temperature difference in a moving air stream whose convective heat transfer coefficient is 5 times that of still air?

Solution: Here, $t_1 = 40\text{min}$; $t_2 = ?$ $h_2 = 5h_1$

We get, $Q_1 = Q_2$

$$\Rightarrow h_1 A \Delta T \times 40 \text{ min} = h_2 A \Delta T \times t_2$$

$$\Rightarrow h_1 A \Delta T \times 40 \text{ min} = 5h_1 A \Delta T \times t_2$$

$$\therefore t_2 = 8 \text{ mins (Answer)}$$

8. Ultimate tensile stress=750 MPa, yield tensile stress= 670 MPa, endurance strength =200 MPa, mid-range stress= 110 MPa, alternating stress=190 MPa. Find shear yield stress by maximum distortion energy theory or maximum shear stress theory.

Solution: Given that, $\sigma_u = 750\text{MPa}$; $\sigma_y = 670\text{MPa}$; $\sigma_e = 200\text{MPa}$;

$\sigma_m = 110\text{MPa}$; $\sigma_a = 190\text{MPa}$;

$$\text{We get, } \frac{1}{F.S} = \frac{\sigma_m}{\sigma_u} + \frac{\sigma_a}{\sigma_e} = \frac{110}{750} + \frac{190}{200}$$

$$\therefore F.S = 0.912 \text{ (Factor of Safety less than 1 represents likely failure)}$$

According to maximum shear stress theory,

$$\tau_{y\max} = \frac{\sigma_y}{2 \times F.S} = \frac{670}{2 \times 0.912} = 367.4 \text{ MPa (Answer)}$$

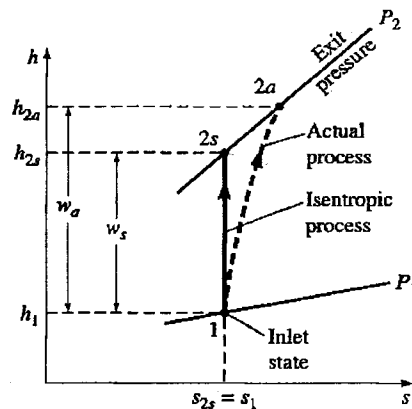
9. What is isentropic efficiency? Show the equation of isentropic efficiency of a compressor in terms of enthalpy with necessary diagram.

Solution: Isentropic efficiency is a parameter to measure the degree of degradation of energy in steady-flow devices. It involves a comparison between the actual performance of a device and the performance that would be achieved under idealized circumstances for the same inlet and exit states.

$$\eta_c = \frac{\text{Isentropic compressor work}}{\text{Actual compressor work}}$$

$$= \frac{W_s}{W_a}$$

$$= \frac{h_{2s} - h_1}{h_{2a} - h_1}$$



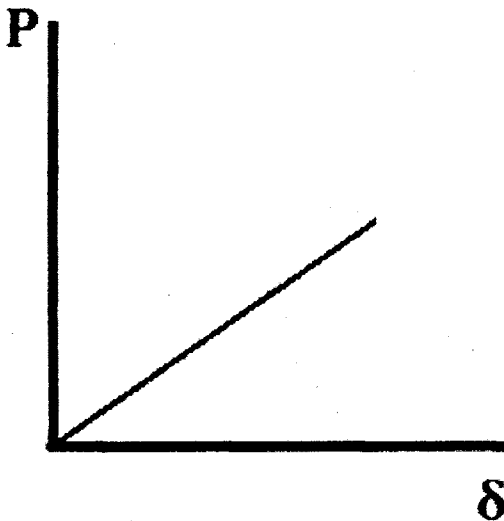
10. a) A cantilever beam has a concentrated load P at end of the tip with deflection δ .

Write the expression for relation between P and δ . Draw P - δ curve.

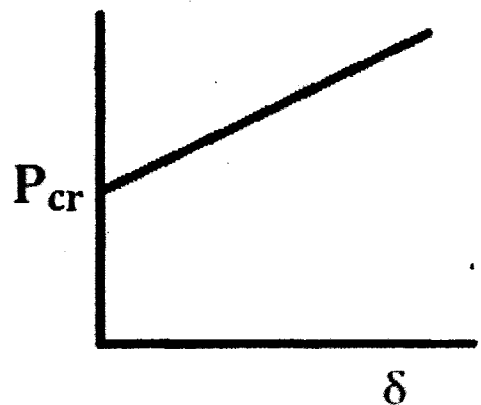
b) A column clumped on both side has an axial load P . The column is not slender and the span deflection is δ . Draw the P - δ curve showing buckling load.

Solution:

(a) $\delta = \frac{PL^3}{3EI}$



(b) $\delta =$

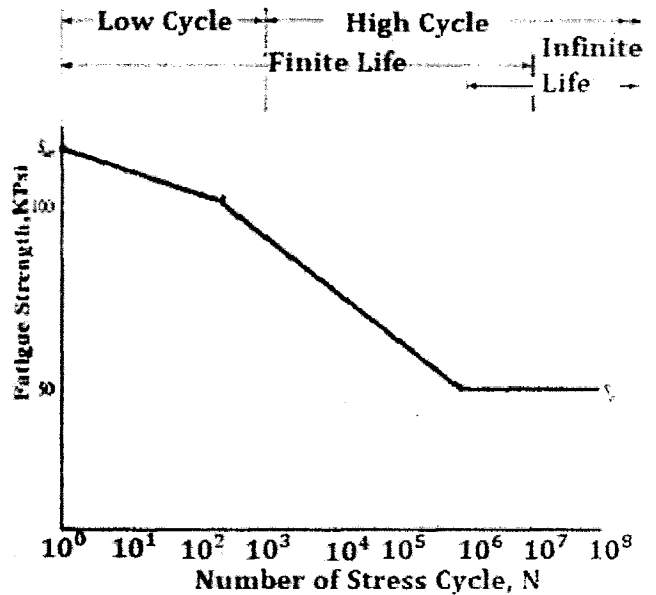
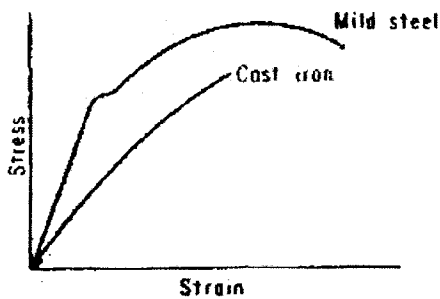


N.B. This solution has no referral documents.

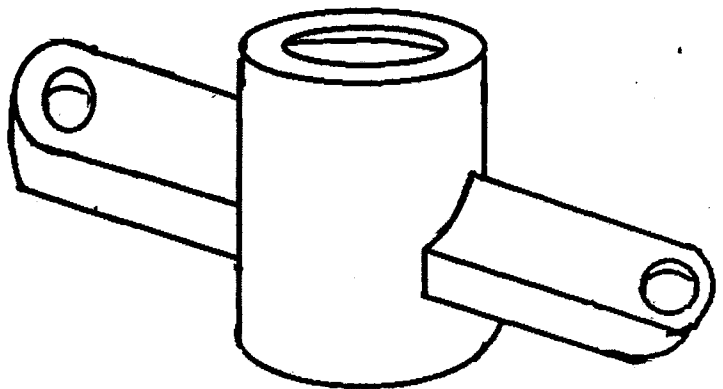
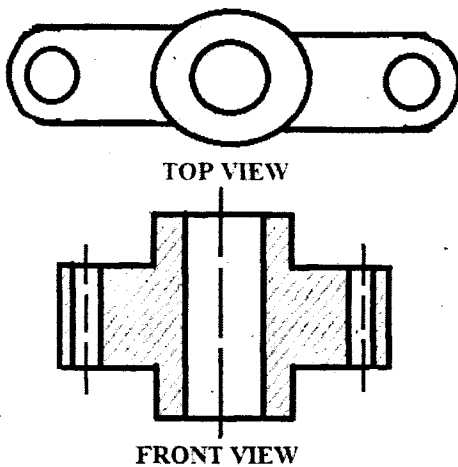
11. a) In a same tensile stress-strain diagram show the graph for (i) CI material and (ii) MS material

b) Plot the fatigue strength (S) versus number of stress cycle (N) curve of a machine element made of steel.

Answer:



12. Draw Top and Front Section view. The cutting plane will pass through the center of the cylinder, including holes. [Similar]



Power Grid Company of Bangladesh Limited(PGCB)

Post: Assistant Engineer(Mechanical)

Time-10.00AM to 11.30AM

Date:19.07.2019

Exam Hall: ME Building, BUET

[Marks Distribution: Departmental- 40 Non Departmental-60]

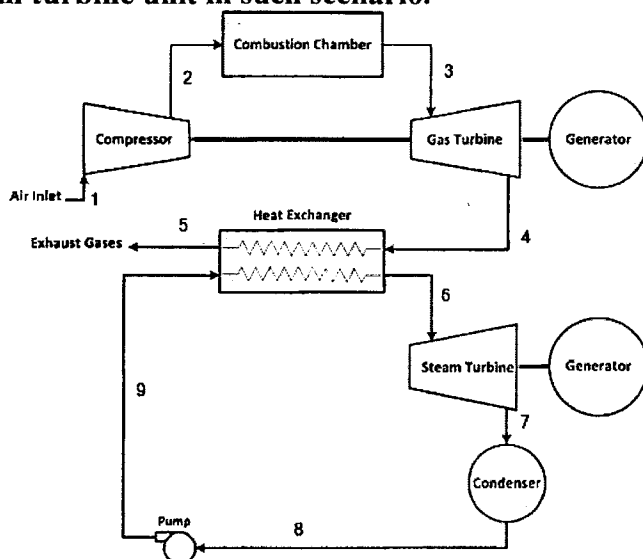
Non-departmental

1. A bag contains 2 Red, 3 Green and 2 blue balls. Two balls are drawn randomly from the bag. What is the probability that none of them is blue? Answer: ${}^5C_2 / {}^7C_2 = \frac{10}{21}$
2. A and B can do a work with 30 days. A do the work together 20 days and then rest of the work done by B in 20 days. What time will take for B to complete the work alone.
 $(A+B)$'s 3 days work = $(\frac{1}{30}20) = 2/3$
 Remaining work = $1 - \frac{2}{3} = 1/3$
 $1/3$ portion of work done by B alone in 20 days
 So, whole work done by B alone in 60 days
3. $2^{32} + 1$ divisible by which number?
 Let $2^{32} = x$. Then, $(2^{32} + 1) = (x + 1)$.
 Let $(x + 1)$ be completely divisible by the natural number N. Then,
 $(2^{96} + 1) = [(2^{32})^3 + 1] = (x^3 + 1) = (x + 1)(x^2 - x + 1)$, which is completely divisible by N, since $(x + 1)$ is divisible by N.
 Answer: $(2^{96} + 1)$.
4. When length of a rectangle is halved and width tripled. What will be the change of rectangle area? Answer: 50% increase.
5. 66 cubic centimeter cube drawn into wire of 1cm diameter. What will be the length of the wire?
 $\frac{\pi}{4}D^2L = a^3 = 66$ or, $L=84.03\text{cm}$
6. A, B, C & D have been divided some amount of money in following ratio 5:2:4:3. If C received 1000 more than D, then what amount did B receive? Answer: 2000
7. The least number when divided by 5, 6, 7 and 8 leaves reminder 3 but when divided by 9 no reminder. Answer: 1683
8. To fill a tank 25 buckets of water is required. How many buckets of water required to fill same tank if the capacity of bucket is reduced to $2/5^{\text{th}}$ of its present. Answer 62.5
9. Father is 26 years older than his son is. Two years after father age two times of son age. Present age of son is . Answer: 24yrs
10. Two trains travelling at equal speed, each having length of 120m, coming from opposite direction, crossed each other within 12s. What speed they are travelling at? Answer: 36km/h
11. One boy gets 9 marks more than another and his marks 56% of the sum of their marks. What are his marks? Answer: 42

12. $\log 5 + \log (5x+1) = \log (x+5) + 1$; 10 base log... x? Answer: 3
13. Find wrong number in series. 8, 18, 57, 232.... Answer: 228 $\{ \{(7 \times 1) + 1 \}, \{(8 \times 2) + 2 \}, \{(18 \times 3) + 3 \}, \{(57 \times 4) + 4 \} \}$
14. বাংলাদেশ এ প্রথম টাকা কত সালে কত তারিখ এ চালু হয়? উত্তর-4 march, 1972
15. Which European country recognized Bangladesh first? Ans- East Germany.
16. What PGCB does besides power distribution? Ans- Optical fiber leased to local telecommunication company.
17. বাক্যে মাঝে মাঝে উহ্য থাকে- ক্রিয়া
18. PGCB 's highest transmission voltage?
19. চাঁদের হাট অর্থ কি- প্রিয়জনদের সমাগম
20. সমাস ভাষাকে কি করে?- সংক্ষেপ করে
21. Who is the designer of national flag of Bangladesh? Kamrul Hasan
22. Father of science fiction- H.G. Wells.
23. Greenland belongs to which country-Denmark
24. Capital of Vietnam – Hanoi.
25. What is the total number of districts in Dhaka division? –recent 8
26. What is single-phase voltage in Bangladesh— 0.230KV
27. Higher value of pressure of blood is called – systolic pressure
28. Greenhouse gases- carbon dioxide, methane, nitrous oxide etc.
29. Glimpses of world history- by Jawaharlal Nehru (collection of 196 letters on world history)
30. 'লা' কোন উপসর্গ- আরবি
31. Prime colors- RGB i.e. Red, Green, Blue
32. NATO Headquarter- Brussels, Belgium
33. Bangladesh imports - LNG
34. Which one higher calorific value- Gas
35. Which Bangladeshi river originates from Tibet? –Brahmaputra
36. বহিপীর কি? –নাটক (সৈয়দ ওয়ালিউল্লাহ)
37. Constitution of Bangladesh effective from- 16 December, 1972
38. কোন বীরশ্রেষ্ঠ এর কবর শুরু তে ভারতে ছিল?- হামিদুর রহমান
39. Largest Delta of the world in which Bangladeshi river? Ganga
40. The least effect on transmission tower is ____
41. DNA fragmentation done by which process? Electrophoresis
42. By which material PGCB transmission lines made? Aluminum
43. What is the demand percentage with total generation?

Departmental

1. Draw Schematic diagram of combined cycle power plant and amount of power produced from steam turbine unit in such scenario.

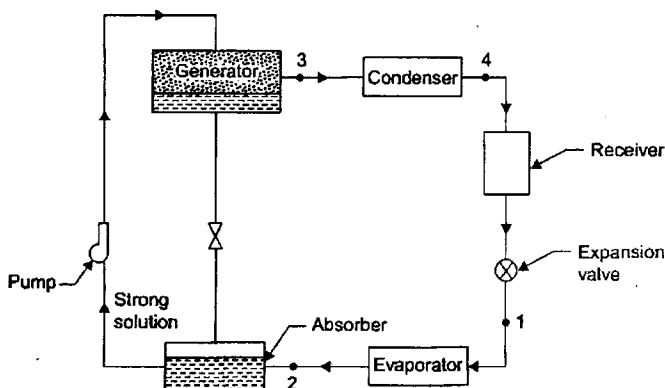


Maximum efficiency of a GT-ST combined cycle is around 62%. A combined-cycle power plant uses both a gas and a steam turbine together which produces up to 50 percent more power from the same fuel than a traditional simple gas turbine plant.

9. Draw schematic of vapor absorption refrigeration system. Mention the advantages of it.

Answer: Advantages of vapour absorption refrigeration system:

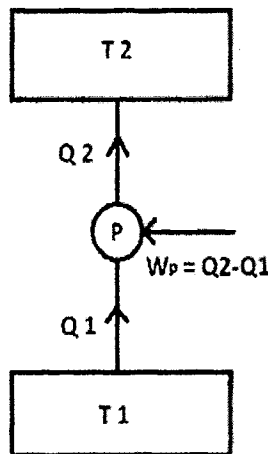
- There is no moving parts except pump-motor which is a small element of the system.
- Smooth running, low maintenance cost.
- COP is higher.
- Use low-grade energy like heat.
- Automatic operation for controlling the capacity is easy.



3. Draw the schematic diagram of heat pump. If it is accomplished by 1 TOR air

conditioner which runs at 1 KW power, then what is the COP & how much heat was supplied?

Solution:



Heat extract from source is, $Q_1 = 1 \text{ TOR} = 3.5 \text{ KW}$

$(\text{COP})_R = \text{Refrigeration effect/input power} = 3.5/1 = 3.5$

$(\text{COP})_p = 3.5 + 1 = 4.5$ & Heat supplied $Q_2 = 4.5 \text{ KW}$ (Answer)

4. In a counter flow heat exchanger water is cooled from 22°C to 6°C using brine which enters at -2°C and leaves at 3°C . If overall heat transfer co-efficient is $500 \text{ W/m}^2\text{C}$ and heat transfer rate is 10 KW then calculate the heat transfer surface area.

Solution:

Here, $\Delta T_1 = 22 - 3 = 19$;

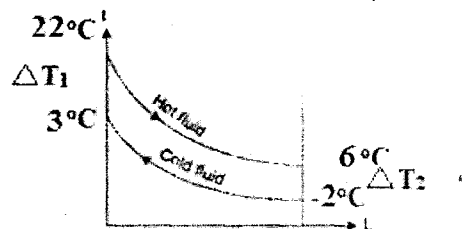
$\Delta T_2 = 6 + 2 = 8$;

$$\therefore \text{LMTD} = \frac{\Delta T_1 - \Delta T_2}{\ln\left(\frac{\Delta T_1}{\Delta T_2}\right)} = \frac{19 - 8}{\ln\left(\frac{19}{8}\right)}$$

$$= 12.7^\circ\text{C}$$

$$Q = UA(\text{LMTD})$$

$$\Rightarrow A = \frac{Q}{U(\text{LMTD})} = \frac{10 \times 1000}{500 \times 12.7} = 1.574 \text{ m}^2 \text{ (Answer)}$$



5. 6" pump operating at 1770 rpm and flow rate of 1500 gpm has a head of 80 ft with 80% efficiency. If another homologous 8" pump of 1170 rpm is used for replacement of this pump then find capacity, head and flow rate of replacement pump.

Solution: $D_1 = 6 \text{ in}$; $Q_1 = 1500 \text{ gpm}$; $N_1 = 1770 \text{ rpm}$; $H_1 = 80 \text{ ft}$; $\eta_1 = 80\%$

$D_2 = 8 \text{ in}$; $N_2 = 1170 \text{ rpm}$; $Q_2 = ?$ $H_2 = ?$

From the similarities, $\frac{\sqrt{H_1}}{D_1 N_1} = \frac{\sqrt{H_2}}{D_2 N_2}$ or, $\frac{H_2}{H_1} = \left(\frac{D_2 N_2}{D_1 N_1}\right)^2$ so, $H_2 = H_1 \left(\frac{D_2 N_2}{D_1 N_1}\right)^2 = 62.14 \text{ ft}$.

Now $\frac{Q_1}{D_1^3 N_1} = \frac{Q_2}{D_2^3 N_2}$ or, $Q_2 = \frac{D_2^3 N_2}{D_1^3 N_1} Q_1 = 2350.2 \text{ gpm}$

Pump capacity means maximum flow rate (gpm) at designed conditions (efficiency, head).

At 80% efficiency and 62.14 ft head, pump capacity is 2350.2 gpm.

6. A 1cm diameter shaft with gauge length of 25 cm is used for tensile test. If tensile load 25 kN causes the deformation of 0.0227 cm then find out modulus of elasticity.

Solution: $P=25\text{ kN}$, $L=25\text{ cm}$, $D=1\text{ cm}$, $A=\frac{\pi}{4} \times 0.01^2 = 7.85 \times 10^{-5} \text{ m}^2$, $E=?$

$$\delta = \frac{PL}{AE} \text{ or, } E = \frac{PL}{A\delta} = 3.5056 \times 10^{11} \text{ Pa} = 350.56 \text{ GPa (Answer)}$$

7. A solid steel shaft 5 m long is stressed at 80 MPa and twisted through 4° . Using $G = 83 \text{ GPa}$, compute the shaft diameter. What power can be transmitted by the shaft at 20 Hz?

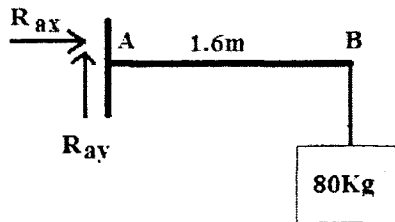
$$\text{Solution: } \tau = \frac{16T}{\pi D^3} \text{ or, } T = \frac{\pi D^3 \tau}{16} = 15.7 \times 10^6 \text{ D}^3 \text{ Nm}$$

$$\text{Now, } \theta = \frac{TL}{GJ} \text{ or, } 4 \frac{\pi}{180} = \frac{15.7 \times 10^6 \text{ D}^3 \times 5}{83 \times 10^9 \times \frac{\pi}{32} \text{ D}^4} \text{ so, } D = 0.1379 \text{ m} = 13.79 \text{ cm}$$

$$P = T \times 2\pi f = 15.7 \times 10^6 \times (0.1379)^3 \times 2\pi \times 20 = 5173.7 \text{ kW (Answer)}$$

8. A 80kg mass is supported at the tip of long AB rigid bar shown in figure. Find the reactions at point A.

Solution:

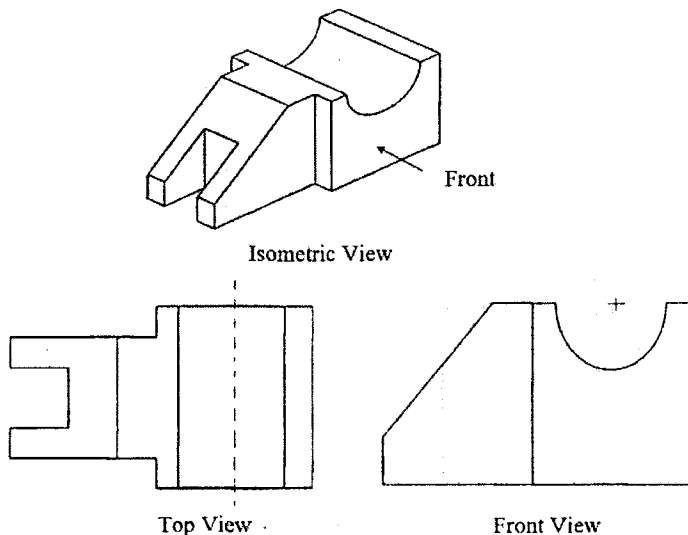


$R_{Ax}=0$ and $+\uparrow \sum F_y = 0$ or, $R_{ay} - mg = 0$ so, Reaction at A, $R_{ay} = 80 \times 9.81 = 784.8 \text{ N}$
& $M_A = 784.8 \times 1.6 = 1255.68 \text{ Nm (Answer)}$

9. Friction related math.

Solution: Fundamentals of Mechanical Engineering by Emran Hossain - Engineering mechanics-problem no 15

10. Draw top and front view.



North West Power Generation Company Limited(NWPGCL)

Post: Assistant Engineer(Mechanical)

Time-10.00AM to 11.30AM

Date:25.10.2019

Exam Hall: ECE Building, BUET

[Marks Distribution: Departmental-40 Non Departmental-60]

Non Departmental

1. In a flight of 600 km, an aircraft was slowed down due to bad weather. Its average speed for the trip was reduced by 200 km/hr and the time of flight increased by 30 minutes. The duration of the flight is _.

Solution: Let the duration of the flight be x hours.

Then $\frac{600}{x} - \frac{600}{x+\frac{1}{2}} = 200$ By solving we get, $x=1\text{hr}$ (Answer)

2. A number when divided by 6, remainder 3. If its square value is divided by 6, how much will be the remainder.

Solution: Let the number is x , so $x = 6q + 3$.

[we know, dividend= divisor*quotient + remainder]

Then, $x^2 = (6q + 3)^2$

$$= 36q^2 + 36q + 9$$

$$= 6(6q^2 + 6q + 1) + 3$$

Thus, when x^2 is divided by 6, then remainder = 3.

3. Each Train has a length of 120m travelling in opposite direction. They pass each other after 12 seconds. If both the trains have same velocity then find the velocity.

Solution: Let the speed of each train be x m/sec.

Then, relative speed of the two trains = $2x$ m/sec.

So, $2x = (120+120)/12$

$$24x=240$$

$$X=10\text{m/sec}=36\text{km/hr}$$

4. 3 years ago the average of Father, son & mother was 27 ; 5 years ago average of mother& son age 20 years, now how much is the father's age?

Solution: : Let , present age of father, mother and son are x, y and z respectively.

For 3 three years ago, $\{(x-3)+(y-3)+(z-3)\}/3=27$ or, $x+y+z=90$

For 5 years ago, $\{(y-5)+(z-5)\}/2=20$ or, $y+z=50$

By solving above equations we get, $x=40$ year (Answer)

5. A 10 m long ladder makes an angle 60° with the horizontal ground. What is the length from top of the ladder to the bottom of the wall along the wall?

Solution: Height = $10\sin 60 = 5\sqrt{3}$

6. A and B are two numbers such that the sum of 5% of A and 4% of B is two third to the sum of 6%of A and 8% of B. Then find the ratio of A& B

Solution: $5\%A+4\%B=(2/3)(6\%A+8\%B)$ or, $A/B= 4/3$

7. $(x+3)^2=225$; which of the following could be the value of $x-1$

Solution: $(x+3)^2=225$ or, $x+3=15$ & -15 . so $x=12$ or -18 . Ans:-19

8. Square root (x) is integer and $xy^2=36$. Then how many values are possible for the integer y?

Solution: possible root over (x) values are (1,2,3,4,-1,-2,-3,-4). So number of y values is 8.

9. In a class 75% of boys and 48% of girls take math. No of boys is less than 20% of girls. Total % of students take math.

Solution: possible solution....let number of boys and girls is x & y respectively.

Then $x=y-0.2y=.8y$ and total number of students $x+y=0.8y+y=1.8y$percentage of students taking math = $(0.75x+0.48y)/(x+y)$ By putting the of $x=0.8y$ and $x+y=1.8y$ we get 0.6 i.e. 60%.

10. Length and breadth of a rectangular sheet are 30 and 18 respectively. If a person wants to cut it to form several square sheets then how many sheets can he prepare without losing any part of the sheet?

11. Sajal is 12 years older than Ratan. After 6 years his age will be twice as that of Ratan. How old is Ratan now?

Solution: let the age of sajal and rattan is x & y respectively. Then $x=y+12$ and $x+6=2(y+6)$ By solving these equations we get $x=18$, $y=6$

12. Perimeter of a rectangular patio is 268 feet and length=168%width, what is area of rectangular patio.

Solution: let the length is x and width is y. then $2(x+y)=268$ and $x=168\%y=1.68y$ By solving these equations we get $x=84$ $y=50$; area=4200 square feet.

13. 12 person can pack 60 boxes in 9 minutes at a constant rate. How much minutes do 27 person take for packing 180 boxes.

Solution: 12 person can pack $60/9$ (boxes/min)

So, 27 person can pack $(60 \times 27)/(12 \times 9)$ boxes/min = 15 boxes/min .

packing 15 boxes in 1 min

packing 180 boxes in $(180/15)=12$ min.

14. 4 persons contribute some money to run a charity. The average contribution of each is 20tk, if each of them can contribute maximum 25tk then what is the minimum amount one can contribute?

Solution: Total amount of contribution = $4 \times 20 = 80$ tk. If three of them contribute 25tk then total = 75tk...so one can contribute minimum = $80 - 75 = 5$ tk.

15. Area of an circle is 4π . If radius is doubled then what will be the area of the circle.

Solution: let original area is a and after doubled radius area is A. So $a=4\pi=\pi r^2$ and $A=\pi \times 2r^2$

$A/a=4$ i.e. $A=4a$.

16. $\log_{10} 5 + \log_{10} (5x+1) = \log_{10} (x+5) + 1$ then $x=3$ (Answer)

17. A bag contains 2 red, 3 green and 2 blue balls. Two balls are drawn at random.

What is the probability that none of the balls drawn is blue?

Solution: ${}^5C_2 / {}^7C_2 = 10/21$

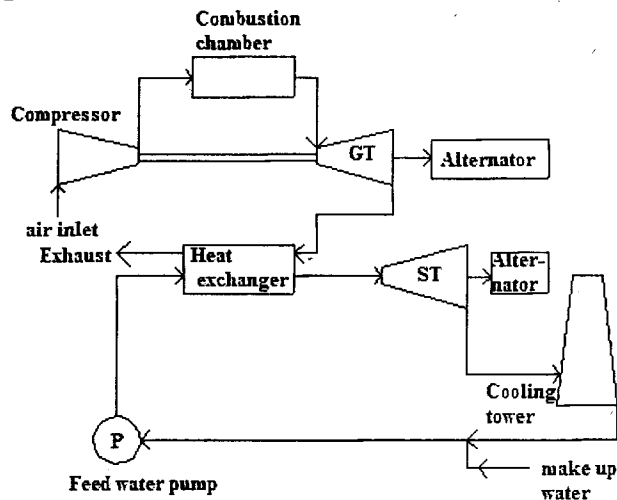
18. For household bulbs and fan supply voltage –. Answer: 0.23kv

19. Bangladesh imports around 600MW from India. 20. Maximum electricity generation is 12GW.

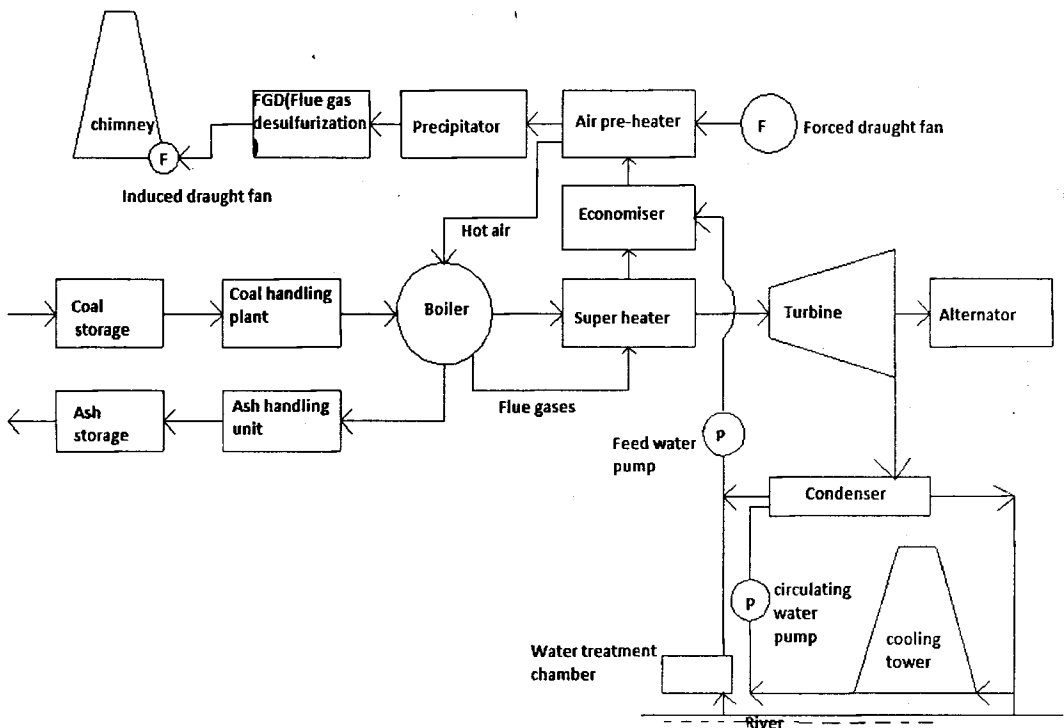
21. Generation capacity of NWPGL is 1410MW.
22. Currently which coal base thermal plant is now in operation –250MW (Barapukuria thermal power plant, Dinajpur.)
23. 1320 MW Payra Thermal Power plant is under BCPCL (joint venture of Chinese CMC and NWPGL)
24. The only nuclear power plant will be situated at Rooppur.
25. Per capita energy consumption in Bangladesh is 310MW (according to 2014 report)...In the option maximum 310 or 350kwh was given.
26. Percentage of power is now generating under public sector-50%(private 44% & import 6%.Source BPBD present generation report)
27. which one is used for more than 50% power generation -natural gas
28. আলাওল কোন রাজ সভার কবি? আরাকান রাজসভার কবি
29. সর্বভূক শব্দের প্রতিশব্দ-আগুন
30. বিশ্বজনের হিতকর – এক কথায় প্রকাশ- বিশ্বজনীন
31. কোনটি অপ্রাণিবাচক শব্দের বহুবচনে কোনটি ব্যবহৃত হয়-পুঞ্জ, রাশি, মালা, দাম ।(অপশনে কোনটা ছিল মনে নাই)
32. সন্ধির প্রধান সুবিধা কি? উচ্চারণের সুবিধা
33. They asked to call in a doctor. Call in (ডাকিয়া পাঠানো)
34. Ten to one means very probably/very likely.
35. The masculine of bee is drone.
36. Which one is the relative pronoun- examples: who/whom/which/that/whose/where/when/why.
37. The age limit for being president in Bangladesh is 35.
38. River Padma enters in Bangladesh through Chapainawabganj.
39. Which Bengali person achieved noble prize in economic science prize in 2019-Avijit Banarjee.
40. Light year is used for measuring – distance
41. In which year China recognised Bangladesh -1975
42. Who is the architect of Shahid Minar- Hamidur Rahman
43. Taj mahal is situated in- Agra
44. Bangladesh is a member of WTO/ASEAN/OPEC/(Bangladesh is a member of both WTO and ASEAN but not OPEC. May be question will be like this-Bangladesh is not member of.....)
45. In terms of land area which one is the largest district of Bangladesh -Rangamati
46. Robi crops are....monsoon season crops.
47. From Which mugal emperor's rule Bengali new year was started to celebrate -Akbar
48. Which one is fossil fuel--mineral oil
49. Which acid is used in ordinary electric cell_ . Sulfuric Acid
50. Which one is used for nuclear energy and weapon. - Uranium
51. 10 bulbs each of 110W-220volt are lightening. How much energy do they consumed in 10 hours?- 11kwh.

Departmental

1. HSD=High Speed Diesel, LPG=Liquefied Petroleum Gas, BTU=British Thermal Unit, HFO=Heavy Fuel Oil, CNG=Compressed Natural Gas
2. NWPGL has planned 250 MW combined cycle power plant at Sirajganj, draw its plant schematic diagram.



3. Draw schematic diagram of 1320MW Payra thermal power plant.



4. A Hydroelectric power plant works under head of 50m and discharge $1.5 \text{ m}^3/\text{sec}$. Turbine generator combined efficiency is 75%. What will be the output of the plant?

Solution: Efficiency, $0.75 = \frac{P}{\gamma Q H} = \frac{P}{1000 \times 9.81 \times 1.5 \times 50}$ so, $P = 551.81 \text{ KW}$

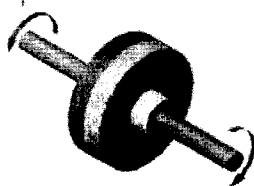
5. Air enters at 100 m/s speed & 200°C , exists at 200 m/s speed, if $C_p = 1.005 \text{ KJ/Kg-K}$, then what will be the exit temperature?

Solution: Enthalpy is converted to kinetic energy. So $mc_p(T_1 - T_2) = \frac{1}{2}m(V_2^2 - V_1^2)$

$$\text{or, } T_1 - T_2 = \frac{1}{2c_p}(V_2^2 - V_1^2) \text{ or, } T_2 = (273 + 200) - (200^2 - 100^2) / (2 \times 1.005 \times 1000)$$

$$= 458.07 \text{ K} = 185.07^\circ\text{C} \text{ (Answer)}$$

6. Determine the number of bolts required having a diameter of 20mm placed around a bolt circle of diameter 400mm that can transmit a torque of 20KNm and allowable shearing stress in the bolt is 40MPa.(flanged bolt coupling)



Solution: The torque is transmitted by the shearing force P ($P = \tau A = \frac{\pi}{4} d^2 \tau$) created in the bolts that is assumed to be uniformly distributed. For any number of bolts n , the torque capacity is,

$$T = PRn = \frac{\pi}{4} d^2 \tau R n$$

$$\text{or, } 20 \times 1000 = \frac{\pi}{4} (.02)^2 \times 40 \times 10^6 \times 0.2 n$$

$$\therefore n = 7.9 \text{ so number of bolts } 8. \text{ (Answer)}$$

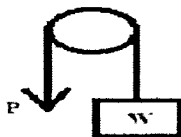
7. In summer highest average temperature is 43°C where as in winter it is 3°C . How much clearance should maintain when rails are laid. Length of the rail is, $L = 10 \text{ m}$, If $\alpha = 0.1 \mu\text{m/m}^\circ\text{C}$ and $E = 20 \text{ GPa}$.



Gap between two rails is maintained to allow for thermal expansion and contraction during hot and cold season.

Clearance/gap = thermal expansion, $\delta = \alpha L \Delta T = (0.1 \times 10^{-6} \times 10 \times 40) = 4 \times 10^{-5} = 0.04 \text{ mm}$

8. A rope has 1.5 times winding on a horizontal bar, at its one end a bar of 300N is placed, if coefficient of friction between rope & bar is 0.3 then what will be the range of P will be maintained at other end of rope?



Solution: Angle of contact, $\beta = 1.5 \text{ turns} = 3\pi \text{ radian}$

For impending motion of W up, $P = we^{\mu\beta} = 300 \times e^{0.3 \times 3\pi} = 5070.6\text{N}$

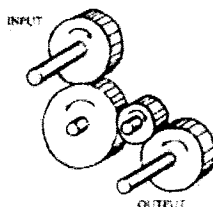
For impending motion of W down, $P = we^{-\mu\beta} = 300 \times e^{-0.3 \times 3\pi} = 17.74\text{N}$

For equilibrium, $5070.6\text{N} \leq P \leq 17.74\text{N}$ (Answer)

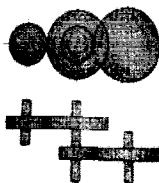
9. Give a name to each of gear arrangement of below figure.

These are not exact figure. But name of gear arrangement is correct according to the figure which were given in the exam.

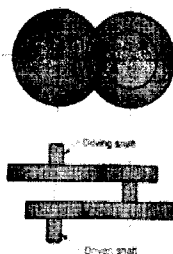
A) Simple gear train



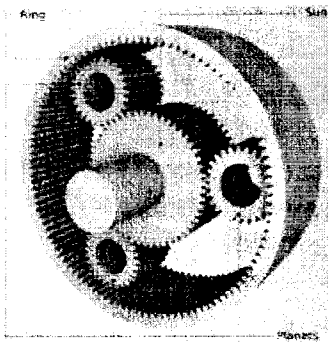
b) Compound gear train



c) Reverted gear train



d) Epicyclic /planetary gear train



10. Drawing [See BCIC question no. 12]

Dhaka Power Distribution Company Limited (DPDC)

Post: AE (Mechanical)

Time-10.00AM to 11.30 AM

Date: 30.08.2019 Venue: BUET

GK+Bangla+English= 50×0.5=25; Analytical = 15×1=15

Departmental = 12×5=60

1. Find the power transmitted by a belt running over a pulley of 600mm diameter at 200rpm. The coefficient of friction between the belt and the pulley is 0.25, angle of lap $\frac{8\pi}{9}$ and maximum tension in the belt is 2500N.

Solution: Given, $d = 600\text{mm} = 0.6\text{m}$; $N = 200\text{rpm}$; $\mu = 0.25$; $\theta = \frac{8\pi}{9} = 2.793\text{ rad}$; $T_1 = 2500\text{N}$

$$\text{We get, } V = \frac{\pi d N}{60} = \frac{\pi \times 0.6 \times 200}{60} = 6.284\text{ m/s}$$

$$\text{Here, } 2.3 \log \left(\frac{T_1}{T_2} \right) = \mu \theta = 0.25 \times 2.793$$

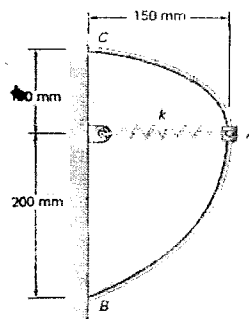
$$\Rightarrow \log \left(\frac{T_1}{T_2} \right) = 0.3036$$

$$\Rightarrow \frac{T_1}{T_2} = 2.01$$

$$\Rightarrow T_2 = 1244\text{N}$$

$$\therefore \text{Power transmitted by the belt, } P = (T_1 - T_2)V = (2500 - 1244) \times 6.284 \\ = 7890\text{W} = 7.89\text{KW (Answer)}$$

2. A 500-g collar can slide without friction on the curved rod BC in a horizontal plane. Knowing that the undeformed length of the spring is 80mm and that $k = 400\text{ kN/m}$, determine the velocity that the collar should be given at A to reach B with zero velocity.



Solution: According to energy conversion,

$$(K.E. + P.E.)_A = (K.E. + P.E.)_B$$

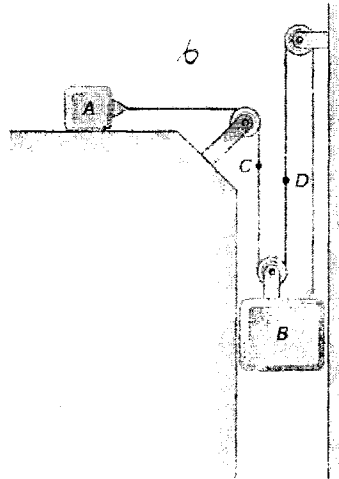
$$\Rightarrow \frac{1}{2} m V_A^2 + \frac{1}{2} K (\Delta x_A)^2 = \frac{1}{2} m V_B^2 + \frac{1}{2} K (\Delta x_B)^2$$

$$\Rightarrow \frac{1}{2} \times 0.5 \times V_A^2 + \frac{1}{2} \times 400 \times 1000 \times (0.15 - 0.08)^2 = \frac{1}{2} m \times 0^2 + \frac{1}{2} \times 400 \times 1000 \times (0.2 - 0.08)^2$$

$$\Rightarrow 0.25V_A^2 + 980 = 2880$$

$$\Rightarrow V_A = 87.2 \text{ m/s (Answer)}$$

3. Slider block A moves to the left with a constant velocity of 6 m/s. Determine (a) the velocity of block B, (b) the relative velocity of portion C of the cable with respect to portion D.



Solution:

From the diagram we have,

$$x_A + 3y_B = \text{constant}$$

Then, $V_A + 3V_B = 0$... (i)

And $a_A + 3a_B = 0$... (ii)

(a) From equation (i), $6 + 3V_B = 0$

or, $V_B = 2 \text{ m/s} \uparrow$ (Answer)

(b) $y_B + y_D = \text{constant}$

$$\Rightarrow V_B + V_D = 0$$

$$\therefore V_D = 2 \text{ m/s} \downarrow$$

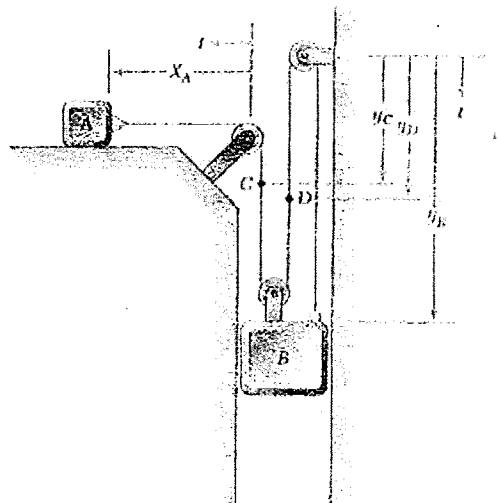
Again, $x_A + y_C = \text{constant}$

Then, $V_A + V_C = 0$

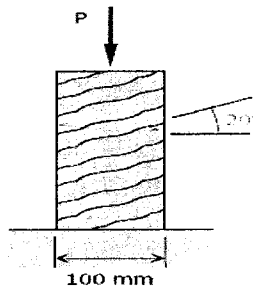
$$\therefore V_C = -6 \text{ m/s} \downarrow$$

Now, $V_{C/D} = -6 - 2 = -8 \text{ m/s} \downarrow$

$$\therefore V_{C/D} = 8 \text{ m/s} \uparrow$$
 (Answer)



4. A rectangular piece of wood, 50 mm by 100 mm in cross section, is used as a compression block shown in Fig. below. Determine the axial force P that can be applied to the block if the shearing stress parallel to the grain is limited to 5 MN/m^2 . The grain makes an angle of 20° with the horizontal, as shown.



Solution: We get,

Shear Force: $V = P \sin 20^\circ$

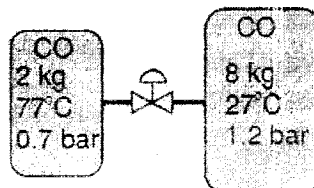
Shear area: $A_V = A_N = 50 \times 100 \sec 20^\circ = 5320.89 \text{ mm}^2$

Here, $V = \tau A_V$

$\Rightarrow P \sin 20^\circ = 5320.89$

$\Rightarrow P = 77.79 \text{ KN (Answer)}$

5. A valve connects two tanks containing carbon monoxide. One tank contains 2 kg of CO gas at 77°C and 0.7 bar. The other tank holds 8 kg of CO gas at 27°C and 1.2 bar. The valve is opened and the gases are allowed to mix while receiving energy by heat transfer from the surroundings. The final equilibrium temperature is 42°C . Using the ideal gas model determine the final equilibrium pressure, in bar. [similar]



Solution:

Then the final equilibrium pressure becomes

$$P_f = \frac{(m_A + m_B)RT_f}{V_A + V_B} = \frac{(m_A + m_B)RT_f}{\frac{m_A RT_A}{P_A} + \frac{m_B RT_B}{P_B}} = \frac{10 \times 315}{\frac{2 \times 350}{0.7} + \frac{8 \times 300}{1.2}} = 1.05 \text{ bar (Answer)}$$

6. A 50-mm-diameter electrical wire is connected with two poles. Determine the drag force exerted on a 30-m-long section of the wire during a windy day when the drag coefficient is 0.45 and the wind is blowing across the wire at 20 km/h. Air density is 1.2 Kg/m^3 .

Solution: Given, $D = 50 \text{ mm} = 0.05 \text{ m}$; $L = 30 \text{ m}$; $C_D = 0.45$;

$V = 20 \text{ Km/hr} = 5.56 \text{ m/s}$; $\rho = 1.2 \text{ Kg/m}^3$. \therefore Fontal area, $A = LD = 30 \times 0.05 = 1.5 \text{ m}^2$

We get, $F_D = C_D A \frac{\rho V^2}{2} = 0.45 \times 1.5 \times \frac{1.2 \times 5.56^2}{2} = 12.52 \text{ N (Answer)}$

7. Discharge of a pump is 20 ltr/s, head 40 m and efficiency 55%. Pump operates 30 min/day. Find electrical energy consumption by the pump in kw-h for 30 days.

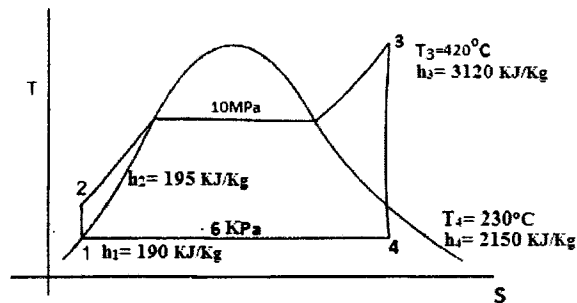
Solution: Here, $Q = 20 \text{ Ltr/s} = 20 \times 10^{-3} \text{ m}^3/\text{s}$ $H = 40\text{m}$, $\eta = 0.55$

We know, Power, $P = \frac{\omega Q H}{\eta} = \frac{9.81 \times 1000 \times 20 \times 10^{-3} \times 40}{0.55} = 14263.09 \text{ W}$
 $= 14.27 \text{ KW}$

Electrical energy consumption per day $= 14.27 \text{ KW} \times \frac{30}{60} = 7.135 \text{ KW} - \text{hr}$

\therefore Electrical energy consumption per month (30days)
 $= 7.135 \times 30 = 214.04 \text{ KW} - \text{hr (Answer)}$

8. T-S diagram of a Rankine cycle corresponding to the pressure and temperature is shown below. Determine the (i) thermal efficiency and (ii) Back Work Ratio.



Solution: We get,

$$\begin{aligned} \text{Thermal Efficiency, } \eta &= \frac{W_T - W_P}{Q_{\text{in}}} \\ &= \frac{(h_3 - h_4) - (h_2 - h_1)}{h_3 - h_2} = \frac{(3120 - 2150) - (195 - 190)}{3120 - 195} \\ &= \frac{970 - 5}{2930} = 0.3293 = 32.93\% \text{ (Ans.)} \end{aligned}$$

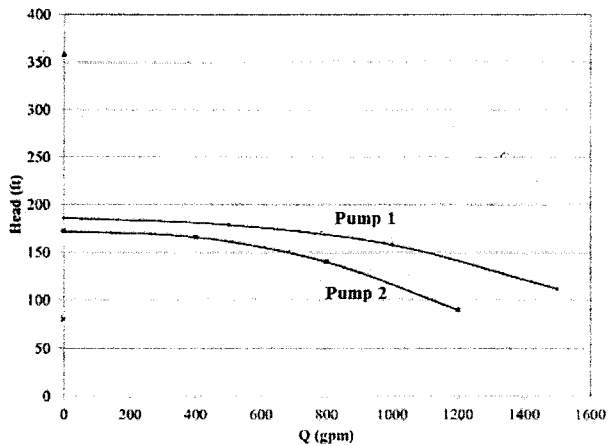
$$\begin{aligned} \text{Back Work Ratio, BWR} &= \frac{W_P}{W_T} \\ &= \frac{195 - 190}{3120 - 2150} = 0.005 \text{ (Ans.)} \end{aligned}$$

9. A room wall 400 mm thick is made of a material having thermal conductivity of 1 W/mK. The inner and outer surfaces are exposed to average temperatures of 20°C and 0°C respectively. If the inner and outer air film coefficient is 0.5 W/m², find the heat flux.

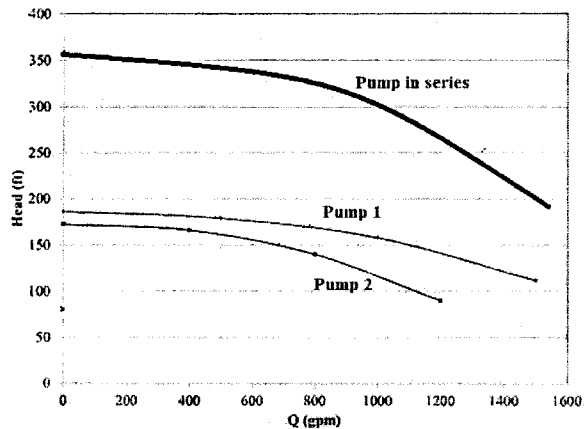
Solution: Given, $x = 400 \text{ mm} = 0.4\text{m}$; $k = 1 \text{ W/mK}$, $T_A = 20^\circ\text{C}$; $T_B = 0^\circ\text{C}$;
 $h_A = h_B = 0.5 \text{ W/m}^2\text{K}$;
 We know that heat flux,

$$\begin{aligned} \frac{Q}{A} &= \frac{(T_A - T_B)}{\frac{1}{h_A} + \frac{x}{k} + \frac{1}{h_B}} \\ &= \frac{(20 - 0)}{\frac{1}{0.5} + \frac{0.4}{1} + \frac{1}{0.5}} \\ &= 4.44 \text{ W/m}^2 \text{ (Answer)} \end{aligned}$$

10. Performance curve for pump 1 and pump 2 are shown. Draw the performance curve when two pumps in series.

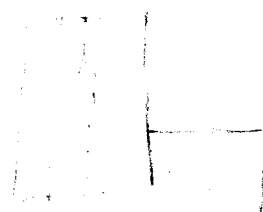
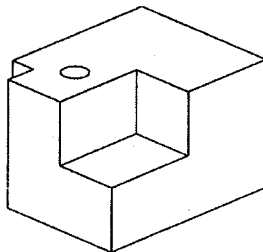


Answer:



11. SFD & BMD

12. Draw TOP VIEW, LHS VIEW & RHS VIEW.



Bangladesh-India Friendship Power Company(Pvt.)Limited(BIFPCL)**Post: Assistant Manager(Mechanical)****Time-10.00AM to 11.30AM****Date:15.11.2019****Exam Hall: ECE Building, BUET****[Marks Distribution: Departmental-50 Non Departmental-50]****Non departmental**

1. How many prime numbers from 1 to 20? Ans-8
2. The sum of 20, 50 and x is 100. If 50 is average of 20,50,x and y. Then what is the value of y? Answer-100
3. A can complete a work within 20 days and B can do the same work within 30 days. How much time needed to complete the work when they are working together? Ans-12days
4. F2, __, D8, C16, B32...? Ans-E4
5. If sum of the three consecutives numbers is 240. Then what is the sum of the largest two? Ans-161
6. When three coins are tossed. Then what is probability of getting head at least one time. Ans-7/8
7. In a class 68% student passed. If passing student is 14 less then passing student would be 45%. How many students are in that class? (kind of this type)
8. $h=80\text{cm}$ hg then $P=?$ Ans-1.07bar
9. Inlet pressure of a series of three compressor is 150Pa. Compression ratio is 2. What is the outlet pressure? Ans-1200Pa
10. Proper and safe functioning for boiler is used- pressure guage/ water level indicator/safety valve/all of above. Ans-all of above
11. Burj khalifa __. Ans: highest bulding /structure in dubai
12. Headquarters of Asian Development Bank is __. Ans-capital of philipine's manila
13. Translate into Bengali-
 - a. Cut your coat according to your cloth (আয় বুঝে ব্যয় কর)-(প্রবাদ বাক্য)
 - b. A bad workman quarrels with his tools (নাচতে না জানলে উঠোন বাক্য)- (প্রবাদ বাক্য)
 - c. As soon as I heard the news I went to see him (খবরটি শুনা মাত্রই আমি তাকে দেখতে গেলাম)
 - d. can't remember
14. Translate into english-
 - a. বাংলাদেশ একটি অপূর্ব ভূমি-Bangladesh is a wonderful land.
 - b. যে বুদ্ধিমান সবাই তার প্রশংসা করে- Everyone praise a man who is intelligent.
 - c. তুমি কি আরেকটু আস্তে কথা বলতে পারবে? Can you talk more slowly?
 - d. প্রকৌশলীরা জাতির মূল চালিকা শক্তি- Engineers' are the driving force of a nation.
16. Marie Curie reading comprehension
(<https://www.testprepreview.com/modules/reading1.htm>)
 - a) The Curies' _____ collaboration helped to unlock the secrets of the atom.
 - Friendly
 - competitive

- courteous
- industrious
- chemistry

b) Marie had a bright mind and a _____ personality.

- strong
- **lighthearted**
- humorous
- strange
- envious

c) Even though she became fatally ill from working with radium, Marie Curie was never _____.

- troubled
- worried
- **disappointed**
- sorrowful
- disturbed

d) can't remember.

15. Write a paragraph on "Impact of electricity on social life"

16. Bulbul originated from ___. Ans- indian ocean.

17. Reptile is to lizard then flower is to ___? Ans-daisy

18. True stress is... ans- greater than engineering stress.

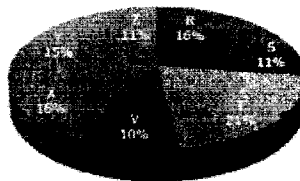
19. Which of the following does not match with others. Core/seed/pulp/slice. Ans-slice

20. In stress strain curve the slope of the proportional limit represents _ ans-the modulus of elasticity.

21. Which one gear is used nonparallel & non intersecting shaft. Ans- spiral gears.

22. Cross section of rectangular is 4x2, find hydraulic diameter. Ans-2.67

23. Proportion of populations of seven village in 1997



Village	% population below poverty line	Village	% population below poverty line
X	38	T	46
Y	52	V	58
Z	42		
R	51		
S	49		

- a) If the population of village R in 1997 is 32000, then what will be the population of village of Y below poverty line in that year? Ans-15600
- b) The ratio of population of village T below poverty line to that of village Z below poverty line in 1997 is_. Ans-23:11
- c) Find the population of village S if the population of village X below poverty line in 1997 is 12160. Ans-22000

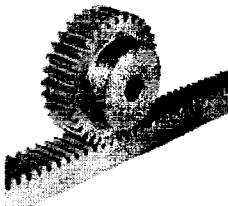
Departmental

1. Name the mechanical components given below.

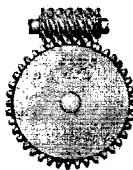
(a) Holding device-bench vice



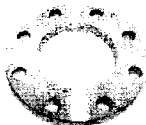
(b) Rack and pinion gear set



(c) worm gear



(d) Flange

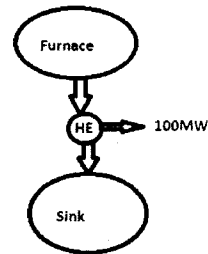


(e) Camshaft

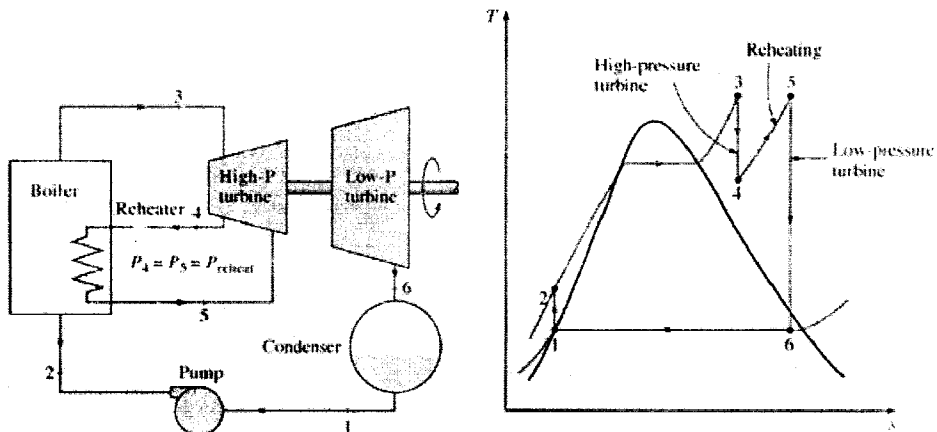


- 2. A powerplant consumes 20,000 litre/h fuel and calorific value of the fuel is 44,000 kj/L. What is thermal efficiency of the plant?**

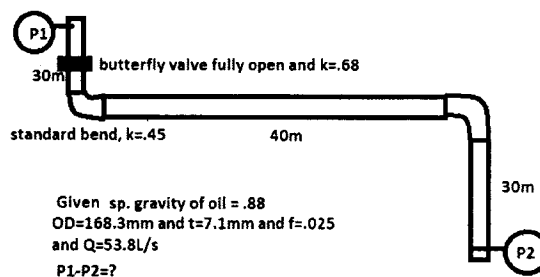
$$\text{Thermal efficiency, } \eta = \frac{100 \times 10^3 \text{ kW}}{20,000 \times 44,000 / 3600} = 0.409 = 40.9\%$$



3. Draw schematic diagram of reheat Rankine cycle with T-S diagram.



4. An oil (sp. Gravity .88) flowing through a pipe (shown in figure) at the rate of 53.8 L/s and outer dia is 168.3mm and thickness is 7.1mm. Friction factor is .025. Determine the pressure difference.



Solution:

$$D = OD - 2t = 168.3 - (2 \times 7.1) = 154.1 \text{ mm}$$

$$\rho = 880 \text{ kg/m}^3$$

$$A = \pi D^2 / 4 = 0.01865 \text{ m}^2$$

$$Q = AV \text{ or } V = 0.0538 / 0.01865 = 2.8 \text{ m/s}$$

As diameter is same all over the path so, $v_1 = v_2 = v$

Applying Bernoulli's equation

$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + Z_2 + (H_{\text{major loss}})_{\text{sum}} + (H_{\text{minor loss}})_{\text{sum}}$$

$$\text{or, } \frac{P_1 - P_2}{\gamma} + 0 + 0 = 0 + 0 + \frac{fv^2}{2gD} (11 + 12 + 13) + \frac{v^2}{2g} [(0.45 \times 2) + 0.68]$$

$$\text{Or, } \frac{P_1 - P_2}{\gamma} = \left(\frac{0.025 \times 2.8^2 \times 100}{2g \times 0.1541} \right) + \frac{2.8^2}{2g} \times 1.58$$

$$\text{Or, } \frac{P_1 - P_2}{\gamma} = 6.48 + .632 = 7.12$$

$$\therefore P_1 - P_2 = 61465.53 \text{ Pa} = 61.46 \text{ KPa (Answer)}$$

5. From the given chart determine a) Flow rate

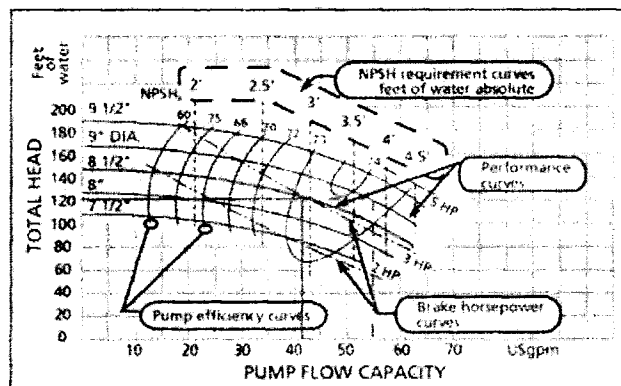
b) Pump efficiency

c) power required (can't remember actually)

when total head is 60m and impeller diameter is 14 inch.

In graph – Total head(in m and ft both are given) vs. Flow rate(gal/min)

(Almost same)



6. In a slider crank mechanism, the crank is rotating with an angular velocity of 20 rad/s in counterclockwise direction. At the instant when the crank is perpendicular to the direction of the piston movement, velocity of the piston is 2m/s. What is the radius of the crank?

Solution: Velocity of slider crank, $V = r\omega[\sin \theta + \sin 2\theta/2n]$

As crank is perpendicular to the direction of the piston movement so, $\theta = 90^\circ$

$$V = r\omega \text{ or, } r = 2/20 = 0.1 \text{ m}$$

7. Find the power transmitted by a belt running over a pulley of 600mm diameter at 200rpm. The coefficient of friction between the belt and pulley is .25. angle of lap 160° and maximum tension in the belt is 2500N.

$$\text{Solution: } V = \frac{\pi DN}{60} = 6.28 \text{ m/s}$$

$$\frac{T_1}{T_2} = e^{\mu\theta} = e^{0.25 \times 160 \times \pi / 180} = 2.009 \text{ so, } T_2 = 1244.4 \text{ N}$$

$$\text{Power transmitted, } P = (T_1 - T_2)V = 7889.16 \text{ W} = 7.9 \text{ KW}$$

8. A cantilever beam needed to design in such a way that stress should be minimum during bending of the beam. For this design circular and square shape beam can select. The diameter of the circle and side of the square is same. What shape will you suggest for minimum stress (By mathematical analysis)? Assume length is same.

Probable solution: $D=a$ (side of square)

For circular shape- bending stress, $\sigma = \frac{MC}{I} = \frac{MD/2}{\pi D^4/64} = \frac{32M}{\pi D^3}$

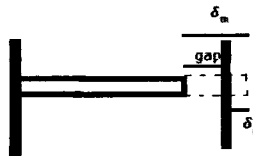
For square shape- bending stress, $\sigma = \frac{MC}{I} = \frac{Ma/2}{a^4/12} = \frac{6M}{a^3} = \frac{6M}{D^3}$

From the equations, bending stress for square shape is less than circular shape.

For minimum stress square shape can be selected.

9. A 2.5m long bar is placed between two rigid walls. The area of the rod is 1200mm^2 . At 20°C the gap is 2mm. If the temperature rises to 200°C . Determine the stress developed into the rod. Taking thermal expansion coefficient $11.7\mu\text{m/m}^\circ\text{C}$ and $E=200\text{GPa}$.

Solution:



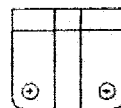
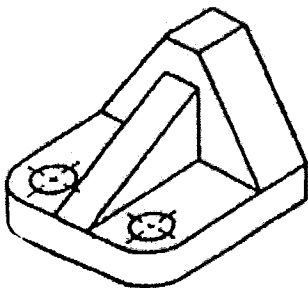
$$\delta_{th} = \text{gap} + \delta_p$$

$$\text{Or, } \alpha L \Delta T = 0.002 + \frac{\sigma L}{E}$$

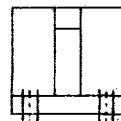
$$\text{Or, } \frac{\sigma L}{E} = (11.7 \times 10^{-6} \times 2.5 \times 180) - 0.002 = 3.26 \times 10^{-3}$$

$$\sigma = 261.2 \text{ MPa}$$

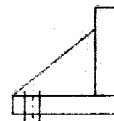
10. Draw the necessary orthographic views of the following figure.



Top view



Front view



Right view

Dhaka Mass Transit Company Limited (DMTCL)**Post: Assistant Project Engineer (Mechanical)****Time-10.00AM to 11.30AM****Date:21.09.2019****Exam Hall: BUET****[Marks Distribution: Departmental—65 Non Departmental—0.5×30=15]****Bangladesh Affairs—5 marks (0.5×10)**

1. Who first made Dhaka as capital – **Islam Khan**
2. Six points movement is compared with __. **Magnakarta**
3. Who started celebration of Bangla new year – **Mughal Emperor Akbar**
4. Who started railways in Indian subcontinent – **Lord Dalhousie**
5. Which two districts/sides will connect Padma Bridge – **Munsiganj to shariatpur and madaripur**
6. How many sectors in 1971? – **11**
7. Teknaf is beside which river – **Naf River**
8. Bangla academy established on - **03 December 1955**
9. Largest land port in Bangladesh – **Benapole**
10. First gas extraction started at DMTCL –

English-5 marks

11. Petrified synonym- **terrified/horrified**
12. He said, "good bye my friend". What will be indirect speech? - He **bade** his friend good bye
13. Um having/taking a cup of tea – **I am taking a cup of tea.**
14. The members selected Mr. Zafar __ President. Option(a, an, the, no preposition)
15. She sent him **to** Grochery of 6th street.
16. Antonym of Protect—**expose/attack/harm**
17. They are opening the shop today. Here 'today' is **adverb**
20. It **has been** raining since 8 O'clock.

MRT related- 5 marks

21. MRT 1 route- **Uttara(airport) to kamlapur(matijeel)**
22. MRT 1 length-**31.24km**
23. Power Transmission of Metro rail—**overhead catenary system**
24. Power source of metro rail – **National grid**
25. Max. Speed of elevated metro rail part—**100 Km/hr**
26. Power consumption by each metro—**6.5MW**
27. How many person will move by each metro – **60,000 passengers per hour**
28. Gauge dimension of Metro line – **1435mm**

29. MRT stands for – **Mass Rapid Transit.**

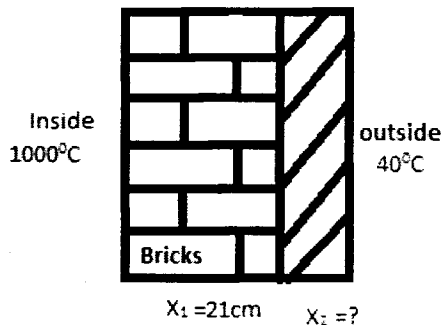
30. PSD stands for – **Platform Screen Doors**

Departmental- 65 (13×5)

1. Show sensible cooling and Cooling & dehumidification in given psychrometric chart.

Answer: Same as Bangladesh China Power Company (Pvt.) Limited (BCPCL)–2018

2. A 21cm thick brick wall having thermal conductivity $k= 1.04 \text{ W/mk}$ and is insulated with a material having $k=0.07 \text{ W/mk}$. Inside & outside temperature 1000°C and 40°C respectively. Heat loss is 960W/m^2 . Find thickness of insulation.



Solution: We get, $Q/A = \frac{\Delta T}{\frac{x_1}{k_1} + \frac{x_2}{k_2}}$ or, $960 = \frac{(1000-40)}{\frac{0.21}{1.04} + \frac{x_2}{0.07}} \therefore x_2 = 0.0558\text{m} = 5.58\text{cm}$ (Answer)

3. Find the thermal efficiency of Otto cycle when compression ratio $r=6$. Pressure 1bar, temperature 288K. Input heat was given 950kJ/kg. Find net work done.

Solution:

Thermal efficiency, $\eta = 1 - \frac{1}{r^{\gamma-1}} = 1 - \frac{1}{6^{1.4-1}} = 51.16\%$

and Net work done = $\eta \times \text{Input heat} = 0.5116 \times 950 = 486.02 \text{ KJ/kg}$ (Answer)

4. 30m long rectangular duct height and width was 3m×1.5m. Velocity of airflow 6m/s. $f=0.091$. Find pressure drop through the duct, air density was 1.07kg/m^3 .

Solution: Assume, flow is fully developed, steady and incompressible.

$V_1=V_2=V=6\text{m/s}$, Hydraulic diameter of rectangular duct, $D_h = 4 \frac{A}{P} = 4 \frac{3 \times 1.5}{2(3+1.5)} = 2\text{m}$,

$\rho = 1.07 \text{ kg/m}^3$ and $L=30\text{m}$.

We get, $\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + Z_2 + H_f$

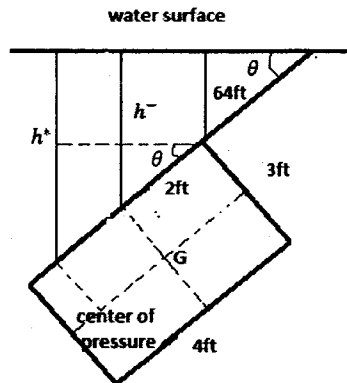
or, $\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + Z_2 + \frac{fLV^2}{2gD}$

or, $\frac{P_1 - P_2}{\rho g} = 0 + 0 + \frac{fLV^2}{2gD}$

$\Delta P = \frac{fLV^2\rho}{2D} = \frac{0.091 \times 30 \times 6^2 \times 1.07}{2 \times 2} = 26.28\text{Pa}$ (Answer)

5. Find hydrostatic force & center of pressure acting on a submerged plane inclined with water surface at 30° . Height & width of plate was 4ft and 3ft respectively. Upper edge is $Y=64$ ft below the free surface. [N.B. there is a confusion about the Y value. This is an assumption]

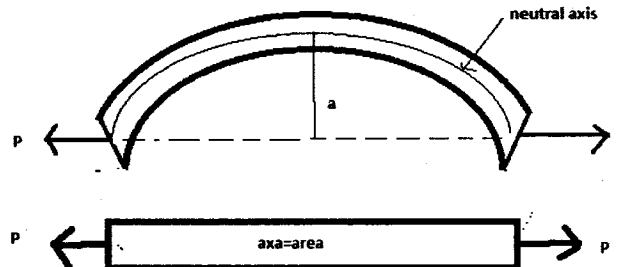
Solution: $\theta = 30^\circ$, $h^* =$ center of pressure, $\bar{h} =$ center of gravity



$$F = \rho g \bar{h} A = 62.428 \times 32.2 \times (64 + 2 \sin 30^\circ) \times 12 = 1567.94 \text{ Klbf}$$

$$h^* = \frac{I \sin^2 \theta}{A \bar{h}} + \bar{h} = \frac{\frac{1}{12} \times 3 \times 4^3 (\sin 30^\circ)^2}{12 \times 65} + 65 = 65.0051 \text{ ft.}$$

6. Two bar subjected to tension. Bar dimension $a'' \times a''$. One bar was straight and other was bended such that distance from neutral axis is a'' . Find normal stress ratio acting on both bars.



Solution:

$$\sigma_1 = \frac{P}{A} = \frac{P}{a^2}$$

$$\sigma_2 = \frac{P}{A} + \frac{Mc}{I} = \frac{P}{a^2} + \frac{aP \times \frac{a}{2}}{\frac{a \times a^3}{12}} = \frac{P}{a^2} + \frac{12aP \times \frac{a}{2}}{a^4} = \frac{7P}{a^2}$$

$$\therefore \frac{\sigma_2}{\sigma_1} = \frac{7P}{a^2} \times \frac{a^2}{P} = 7:1 \text{ (Answer)}$$

7. A pipe of diameter 300mm and the inside pressure is 500KPa . A disk is fitted on the end of pipe with some bolts. Initial tension of each bolt 2KN. If each bolt can withstand maximum 5KN tension. Find out number of bolts.

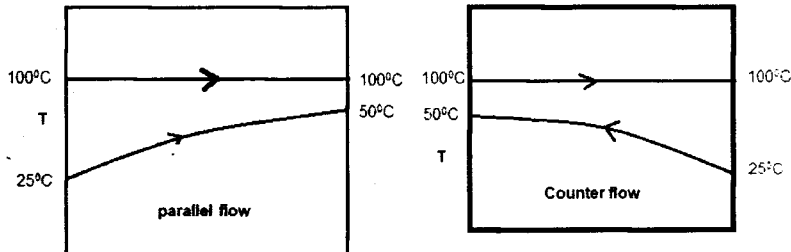
Solution: We get, Pressure force, $F=PA=500 \times 10^3 \times \frac{\pi}{4} \times .3^2 = 35.34 \text{ KN}$

Now, Total force for n number of bolts is, $F_b = n(5-2)=3n \text{ KN}$

So, $F_b = F$ or, $3n = 35.34$ or, $n = 11.78 \therefore \text{No. of bolts required} = 12 \text{ (Answer)}$

8. Saturated vapor 100°C enters in a pipe. Condensed isothermally. Another coolant at 25°C enter in other pipe leaves at 50°C . Find out the value of LMTD for parallel & counter flow. Comment based on their value.

Solution:



For parallel flow, $\Delta T_1 = 100 - 25 = 75^\circ\text{C}$ and $\Delta T_2 = 100 - 50 = 50^\circ\text{C}$

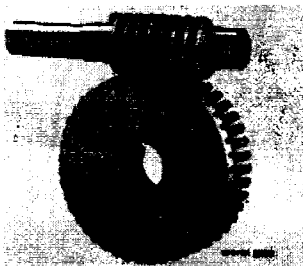
$$\text{LMTD} = \frac{\Delta T_1 - \Delta T_2}{\ln \frac{\Delta T_1}{\Delta T_2}} = \frac{75 - 50}{\ln \frac{75}{50}} = 61.65^\circ\text{C or } 61.65^\circ\text{K}$$

For counter flow, $\Delta T_1 = 100 - 50 = 50^\circ\text{C}$ and $\Delta T_2 = 100 - 25 = 75^\circ\text{C}$

$$\text{LMTD} = \frac{\Delta T_1 - \Delta T_2}{\ln \frac{\Delta T_1}{\Delta T_2}} = \frac{50 - 75}{\ln \frac{50}{75}} = 61.65^\circ\text{C or } 61.65^\circ\text{K}$$

LMTD will be same for both parallel and counter flow. **(Answer)**

9. Name the following given in below.

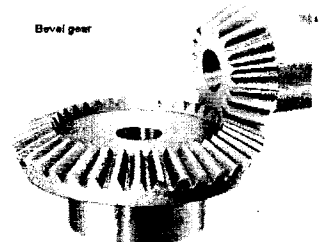


Worm gear



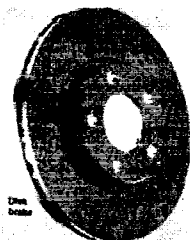
Helical gear

Helical Gear



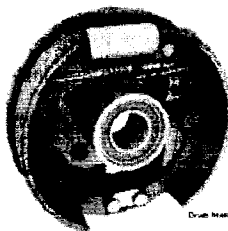
Bevel gear

Bevel Gear



Disk Brake

Disk Brake



Drum Brake

Drum Brake

10. A uniform rod of length L and mass m is supported as shown. If the cable attached at end B suddenly breaks, determine the angular acceleration of AB.

Solution: [See question BIWTA-2019]

11. A 6.5m ladder AB of mass 10kg leans against a wall as shown. Assuming that there is no friction at B, determine the smallest value of coefficient of static friction at A to hold the ladder.

Solution: $F_B=0$, $L=6.5\text{m}$ and $W=98.1\text{ N}$

$$\sum F_x = 0 \text{ or, } R_B = F_A$$

$$\sum F_y = 0 \text{ or, } R_A = W$$

$$\text{and } \sum M_A = 0$$

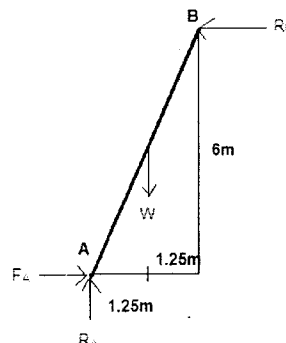
$$\text{or } 6R_B = 1.25W$$

$$\text{or, } 6F_A = 1.25 R_A$$

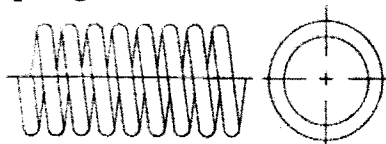
$$\text{Condition for holding the ladder, } \frac{F_A}{R_A} \leq \mu_s \text{ or, } \frac{1.25}{6} \leq \mu_s$$

\therefore Minimum value of static friction coefficient at A,

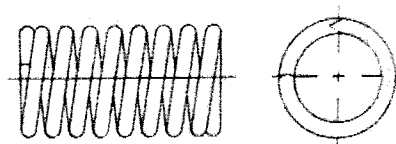
$$\mu_s = 0.208 \text{ (Answer)}$$



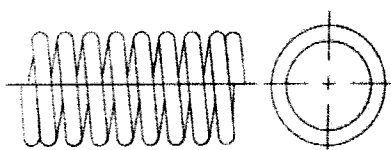
12. Name the spring end condition of the following figures.



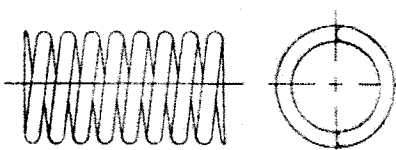
Open Ends
Coiled Right-hand



Closed, Squared and Ground
Ends Coiled Left-hand

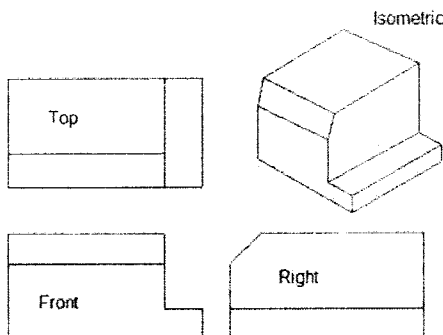


Closed Ends Not
Ground, Coiled Right-hand



Open Ends Ground Square
Coiled Left-hand

13. Draw isometric view from the orthographic view.



Bangladesh Agricultural Development Corporation(BADC)**Post: Assistant Engineer(Mechanical)****Time-10.00AM to 11.30AM****Date:17.01.2020****Exam Hall: EU school & college, BUET****[Marks Distribution: Departmental-40 Non Departmental-40]****Section-A (20 marks)**

1. A number is divisible by 13 and remainder is 11, the same number is also divisible by 17 and remainder is 9. What is the number? **Ans -349**
2. A sum of money distributed among A,B,C & D in the ratio of 5:2:4:3. If c gets 1000tk more than D what is the share of B? **Ans-2000**
3. The age of father is 24 years more than his son. After 2 years father's age is two times of son. What is present age of son? **Ans-22yrs**
4. If length of a rectangular is halved and width triple then which one is correct? **Ans- 50% increase in area**
5. A number 150 is increased by 60% then after decreased by y% result will be 192. What is the value of y? **Ans-20**
6. Synonyms of stringent- **Ans-rigorous**
7. Opposite of transparent- **Ans- opaque**
8. Which sentence is correct?- **Ans- the more he gets, the more he wants.**
9. He serves the people as if he ___ a leader. **Ans-were**
10. Which is not included in seven sisters state? **Ans- Sikkim**
11. Where is manpura island located? **Ans- Bhola**
12. 'The last supper' is a ___. **Ans- painting**
13. What is fair fax? **Ans-News agent**
- ১৪। আমদানি কি শব্দ? **ফারসি**
- ১৫। নিচের কোনটি আকাশের সমার্থক শব্দ- গগন/নীলিমা/নভোঃ/ **Ans -উপরের সবগুলো**
- ১৬। 'ডেকে ডেকে হয়রান হয়েছি' – কোন পদের দ্বিৰুক্তি? **ক্রিয়া**
- ১৭। ক্ষ = **ক+ষ**
- ১৮। কোন বানানটি সঠিক? **ব্রাহ্মগণ**
19. Which emperor first wrote autobiography? **Ans- Babar**
20. What is the plural form of index. **Ans-indices/indexes**

Section-B (20 marks)

1. Comprehension-(read passage and answer three MCQ question)
2. Translations
 - ✓ সাফল্যের জন্য আমি অভিনন্দন জানাচ্ছি।
 - ✓ ব্যাপারটি আমাকে জানানো হয়েছিল।
 - ✓ সে কিছুই করে না শুধু ঘুমায়।
- ৩। ভাষা কী? সাধু ও চলিত ভাষার পার্থক্য কী?

৪। গীতাঞ্জলী কী? কে রচনা করেছেন? আন্তর্জাতিকভাবে এটি পরিচিত কেন?

৫। বৈশ্বিক জলবায়ু পরিবর্তনের প্রভাব সম্পর্কে লিখ।

7. Write a paragraph on 'Green Building'

Departmental- 40

1. Identify the mountings and accessories from the following list

- ✓ Pressure gauge-boiler mounting
- ✓ Steam stop valve-boiler mounting
- ✓ Air preheater-boiler accessories
- ✓ Pressure glass-boiler mounting
- ✓ Economiser –boiler accessories

2. Match the following dimensionless numbers.

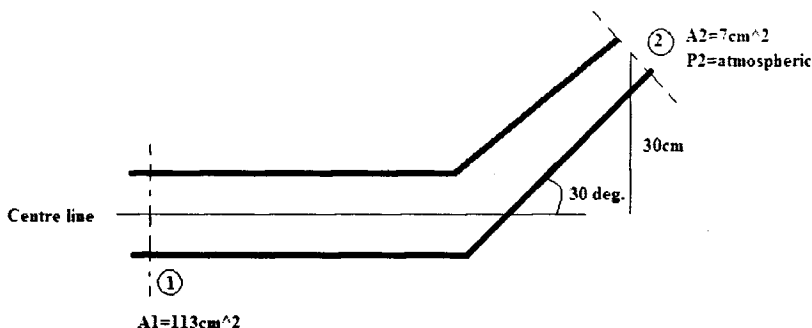
Answer: BIWTA-2019, Page-212

3. A pump is running under a head of 40.8m having discharge 30 L/s. Head loss is 4m. The efficiency of motor is 90% and draws power from 3 phase line of 400V and 25A. Determine the pump efficiency. Considering power factor 1.

$$\text{Solution: Pump efficiency} = \frac{\gamma Q H}{\sqrt{3} V I \cos \theta \times \text{motor efficiency}} = \frac{1000 \times 9.81 \times (0.03) \times (40.8 + 4)}{\sqrt{3} \times 400 \times 25 \times 1 \times 0.9}$$

$$= 0.845 = 84.5\% \text{ (Answer)}$$

4. A reducing elbow is used to deflect water flow at a rate of 14 kg/s in a horizontal pipe upward $\theta = 30^\circ$ while accelerating it. The elbow discharges water into the atmosphere. The cross sectional area of the elbow is $A_1 = 113 \text{ cm}^2$ at the inlet and $A_2 = 7 \text{ cm}^2$ at the outlet. The elevation difference between the centers of the outlet and the inlet is 30cm. The weight of the elbow and the water in it is considered negligible. Determine the gage pressure at the center of the inlet of the elbow.



$$\text{Solution: } V_1 = \text{mass flow rate} / \rho A_1 = \frac{14}{1000 \times 113 \times 10^{-4}} = 1.23 \text{ m/s, Similarly } V_2 = 20 \text{ m/s}$$

Applying Bernoulli's equation

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$$

$$\text{or, } \frac{P_1 - P_2}{\rho g} = \frac{v_2^2 - v_1^2}{2g} + Z_2 - Z_1$$

$$\text{or, } \frac{P_1 - P_2}{\rho g} = \frac{20^2 - 1.23^2}{2g} + 0.3$$

$$\text{or, } P_1 - P_2 = 202186.55 \text{ Pa}$$

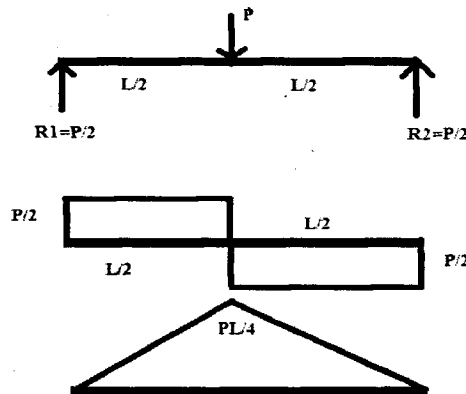
$$\therefore P_{\text{gage}} = 202.18 \text{ KPa (Answer)}$$

5. Showing the following process in psychometrics chart

6. See question – BCPCL-2016 (mechanics-angular velocity of rod AB and velocity of A)

7. Load P is acting middle of a simply supported beam shown in figure. The side of the square cross section of the beam is 'a'. Find the maximum bending stress in terms of a, L and P.

Solution:



$$\text{So, } M = PL/4 \text{ and maximum bending stress, } \sigma = \frac{MC}{I} = \frac{\frac{PL}{4} \times \frac{a}{2}}{\frac{1}{12}a \times a^3} = \frac{3PL}{2a^3} \text{ (Answer)}$$

8. See question – EGCB-2017 (gear ratio math)

9. See Fundamentals of Mechanical Engineering book Volume-1. (Chapter-15 and Page 9-11.)

10. Drawing -See question -CPGCBL-2018

Electricity Generation Company of Bangladesh(EGCB)**Post: Assistant Engineer(Mechanical)****Time-10.00AM to 11.30AM****Date:31.01.2020****Exam Hall: BUET****[Marks Distribution: Departmental-[40+10] Non Departmental-50]****Non departmental-50**

1. How many sub-sector was during liberation war.
2. In which sector Dhaka was – sector 2
3. Headquarter of ADB – **Mandaluyong, Philippines**
4. Education day of Bangladesh – **17 september**
5. Which USA president abolish slavery – **Abraham Lincoln**
6. What is the first poem of 'ognibina' – **proyollash**
7. Which country opposed Bangladesh during liberation war- **China**
8. President of Srilanka – **Gotabaya Rajapaksa (prime minister-Mahinda Rajapaksa)**
9. Next D-8 conference will be held on which city-**April 2020, dhaka**
10. Road Transport Act-2018 effective from – **November 01, 2019**
11. Highest remittance coming from which country – **Saudi Arabia**
12. When did Bangladesh join in IMF – **August 17, 1972**
13. Which is the largest division of Bangladesh – **Chittagong**
14. Which city is not in time interval of GMT – **London**
15. During liberation war Birsresto Ruhul Amin joined in which section – **Engine maintenance nevy**
16. চুলা কোন ভাষার শব্দ – **মুন্ডারী**
17. নিচের কোন বাক্যটি সঠিক – **গরু ছাগলের বিরাট মেলা**
18. The train is **behind** time.
19. When my uncle arrived, I was **watching** TV.
20. Which sector has the largest contribution in GDP of Bangladesh – **Service**
21. Which is the correct spelling – **Recommendation**
22. A train 120m long passes a man in 12 seconds. Find the speed of the train in Km/hr.

Ans- 36Km/hr

23. A and B can do a work in 30 days. A doing work for 16 days and B finished the rest of the work alone in 44 days. How many days required for B to finish the work alone?

Ans-60days

24. A man is 24 years older than his son. In two years his age will be twice of his son. The present age of his son is_. **Ans-22 years**

25. The sum of father, mother and their son's average age 3 years ago was 27 years. The average age mother and his son 5 years ago was 20 years. Present age of the father is_. **Ans-40 years**

26. Rafiq is 12 years older than Ratan. In two years Rafiq's age is doubled of Ratan's age. Ratan's age_. **Ans- 10 years**

27. The ratio of perimeter and breadth of a rectangle is 5:1. If the area of rectangle is 216 cm² then the length is_. **Ans-18cm**

28. $2^{32}+1$ is completely divisible by a whole number. Which of the following number completely divisible by this number? **Ans- (2^6+1)**
29. When a number is divided by 13 then remainder is 11 and the same number is divided by 17 then remainder is 9. What is the number? **Ans-349**
30. Which one is not appropriate_ 7,8,18,57,228,1165 **Ans-228**
31. $\log_{10}5+\log_{10}(5x+1)=\log_{10}(x+5)+1$, $x=?$ **Ans-3**
32. A bag contains 2 red, 3 green and 2 blue balls. When randomly drawn two balls then what is the probability of none of the balls is blue. **Ans-10/21**
33. The angle of elevation of ladder leaning against a wall is 60° and the foot of the ladder is 4.6m away from the wall. The length of the ladder is_. **Ans-9.2m**
34. Two students appeared in an examination. One of them secured 9 marks than other and his marks was 56% of the sum of their mark. The marks obtained by them_. **Ans-42&33**
35. A clock is started at noon by 10 minutes past 5, the hour hand has turned through angle of_ **Ans-155°**
36. If 2nd term is 27 and 5th term is 84 at constant rate then what is the 1st term? **Ans-8**
37. Sum of 5% of A and 4% of B is equal to the 2/3 of sum of 6% A and 8% of B. what is the ratio of A to B? **Ans- 4:3**
38. If four students donated in a charity average taka of 20 each. If no one can't donate more than 25 taka then what is the minimum one can donate? **Ans-5**
39. Who is Bangladesh high commissioner to india – **HE Mohammad Imran**
40. 5 identical machine can produces 270 boxes in 9 minutes. How much time will take for 10 identical machine to produce 800 boxes. **Ans- 40/3 minutes**
41. One voice change.
- 42-50. Unable to Collect.

Departmental MCQ

- What is the capacity of EGCB? **Ans-950MW**
- Which is the base load powerplant-coal/~~neuclear~~/steam/hydro
- Which is non renewable source of energy?sun/wind/~~neuclear~~/biothermal
- EGCB sales electricity to_ **BPDB**
- What is the required space area for photovoltaic cell per MW? **Ans-10 to 15 thousand square meter (not exact)**
- What is capacity of kaptai hydroelectric plant- **230MW**
- What is the required space area for steam power plant per MW? – **2700 to 2800 square meter**
- Which is involved electricity in system loss.- **transmission**
- What is the demand of electricity during winter season? – **75%**

Departmental -40

- A four stroke engine has bore to stroke ratio 0.8. The mean effective pressure is 0.8MPa and incated power is 30 hp and engine speed is 2400rpm. Find out the dimensions of engine.

Solution: Given, $\frac{D}{L} = 0.8$, $P = 0.8\text{MPa}$, $n = \frac{2400}{2} = 1200\text{rpm}$

$$\text{and I. P.} = 30 \times 746 \times 10^{-3} = 22.38 \text{ KW}$$

$$\text{We get, I. P.} = \frac{100 \text{ kPLAN}}{60} \text{ KW}$$

$$\text{or, } 30 \times 746 \times 10^{-3} = \frac{100 \times 1 \times 0.8 \times 10^6 \times L \times \frac{\pi}{4} D^2 \times 1200}{60} = \frac{100 \times 1 \times 0.8 \times 10^6 \times L \times \frac{\pi}{4} (0.8L)^2 \times 1200}{60}$$

$$\therefore L = 3.03 \text{ mm} \text{ \& } D = 0.8 \times 3.03 = 2.42 \text{ mm (Answer)}$$

[N.B. data may be not accurate that's why stroke length as well as bore diameter seems to be abnormal]

2. Steam enters into a superheater at pressure of 9 bar with 95% dry quality and steam leaves superheater at 250°C at constant pressure. Find the change in entropy per unit mass of steam. Given, $C_p = 2.2 \text{ KJ/kg.K}$

Pressure (bar)	S_f (kJ/kg.K)	S_{fg} (kJ/kg.K)	S_g (kJ/kg.K)
9	2.2	4.12	6.32
10	2.4	4.27	6.67

Solution:

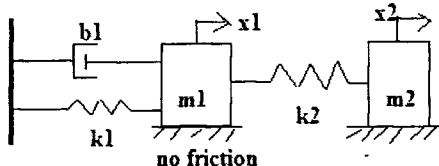
Temperature of saturated steam at 9 bar is 179.97°C

$$\text{Entropy of steam before entering into superheater, } S = S_f + xS_{fg} = 2.2 + 0.95 \times 4.12 = 6.114 \text{ KJ/kg.K}$$

$$\text{Entropy of superheated steam, } S_{\text{sup}} = S_g + C_p \ln \frac{T_{\text{sup}}}{T_{\text{sat}}}$$

$$\text{Change in entropy, } \Delta S = S_{\text{sup}} - S = S_g + C_p \ln \frac{T_{\text{sup}}}{T_{\text{sat}}} - S = 6.32 + 2.2 \ln \frac{250+273}{179.97+273} - 6.114 = 0.522 \text{ KJ/kg.K (Answer)}$$

3. Write the differential equations of the following spring models.



$$\text{For the mass } m_1, -k_1 x_1 - b_1 \frac{dx_1}{dt} + k_2(x_2 - x_1) = m_1 \frac{d^2 x_1}{dt^2}$$

$$\text{or, } m_1 \frac{d^2 x_1}{dt^2} + k_1 x_1 + b_1 \frac{dx_1}{dt} - k_2(x_2 - x_1) = 0$$

$$\therefore m_1 \frac{d^2 x_1}{dt^2} + b_1 \frac{dx_1}{dt} + (k_1 + k_2)x_1 - k_2 x_2 = 0$$

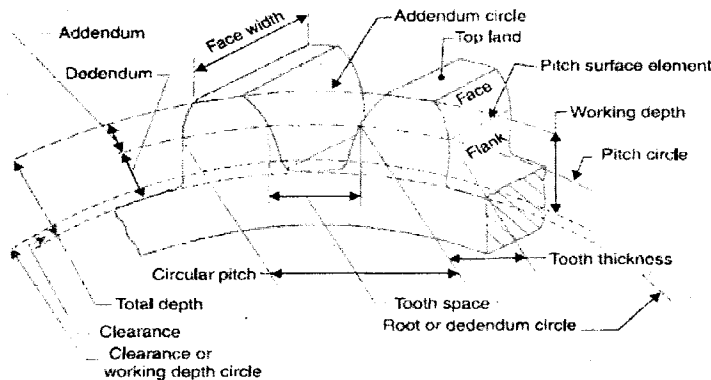
$$\text{For the mass of } m_2, -k_2(x_2 - x_1) = m_2 \frac{d^2 x_2}{dt^2}$$

$$\therefore m_2 \frac{d^2 x_2}{dt^2} + k_2(x_2 - x_1) = 0$$

4. A furnace wall is built up with 100mm thick refractory material and its area is 1m². Inner and outer temperatures are 31°C and 10°C respectively. Thermal conductivity of the material is 0.05 W/m.k. Find out the heat loss through the wall.

$$\text{Solution: } Q = kA \frac{\Delta T}{x} = 0.05 \times 1 \times \frac{21}{0.1} = 10.5 \text{ watts (Answer)}$$

5. Gear (nomenclature)



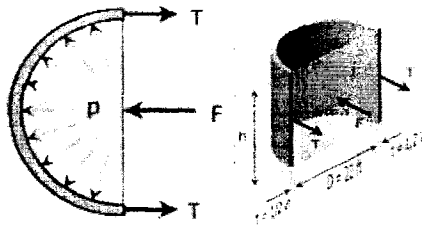
6. A water tank, 22 ft in diameter, is made from steel plates that are 1/2 in. thick. Find the maximum height to which the tank may be filled if the circumferential stress is limited to 6000 psi. The specific weight of water is 62.4 lb/ft³.

Solution: Assuming pressure distribution is uniform.

$$\sigma_t = 6000 \text{ psi} = 6000 \text{ lb/in}^2 = 6000 \times 12^2 = 864000 \text{ lb/ft}^2$$

$$\text{Pressure force, } F = PA = \gamma h \times Dh = \gamma Dh^2$$

$$\text{And Tension in the tank wall, } T = \sigma_t A_t = 864000 \times ht$$



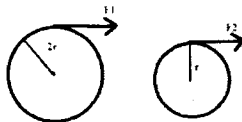
$$\text{Now, } \sum F_x = 0 \text{ or, } F = 2T \text{ or, } \gamma Dh^2 = 2 \times 864000 \times ht$$

$$\text{or, } 62.4 \times 22 \times h^2 = 2 \times 864000 \times h \times \frac{1}{2 \times 12}$$

$$\therefore h = 52.44 \text{ ft (Answer)}$$

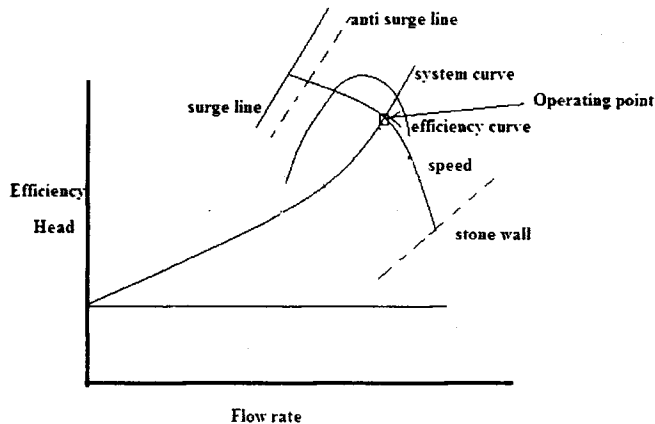
7. Two solid cylinders A and B have the same mass m and the radii $2r$ and r respectively. Each is accelerated from rest with a force applied as shown. In order to impart identical angular accelerations to both cylinders what is the relationship between F_1 and F_2 ?

Solution:



$$\text{Torque} = F \times R = I\alpha \text{ or, } \alpha = \frac{FR}{\frac{1}{2}mR^2} = \frac{F_1 \times 2r}{\frac{1}{2}m(2r)^2} = \frac{F_2 \times r}{\frac{1}{2}mr^2} \therefore F_1 = 2F_2 \text{ (Answer)}$$

8. Draw the performance curve of centrifugal compressor and showing the operating/duty point.



9. A quantity of air having volume of 100 m^3 , temperature 23°C and pressure 100 KPa . The partial pressure of dry air is 95 KPa and relative humidity is 74% . Find out the specific humidity and mass of water vapour present in the air. Take, $R=0.29 \text{ KJ/kg.k}$.

Solution:

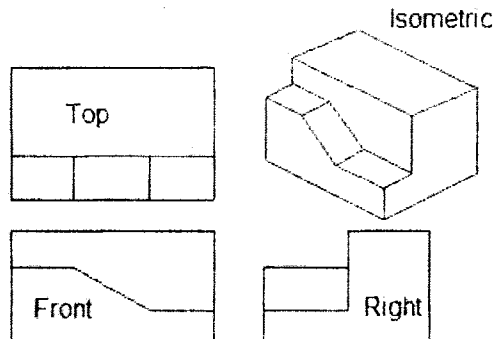
Total pressure, $P=P_a + P_v$ or, $100=95 + P_v$ so, $P_v=5 \text{ KPa}$

Specific humidity/Humidity ratio, $W=\frac{m_v}{m_a} = 0.622 \times \frac{P_v}{P_a} = 0.622 \times \frac{5}{95} = 0.0327 \text{ kg/kg}$ of dry air. **(Answer)**

Mass of water vapor, $W=m_v/m_a$ or, $m_v=W m_a = 0.0327 \times \frac{P_a \times V}{RT} = 3.618 \text{ kg}$

[Source- R.S khurmi thermodynamics-psychrometric relations]

10. Draw the isometric view from the orthographic view.



Barapukuria Coal Mining Company Limited(BCMCL)**Post: Assistant Manager(Mechanical)****Time-10.00AM to 11.30AM****Date:14.02.2020****Exam Hall: ECE building, BUET****[Marks Distribution: Departmental-60 Non Departmental-20]****Non departmental (40 × 0.5 = 20)**

1. Sundarban declared as world heritage site by UNESCO in **1997**.
2. Who introduced Bangla New Year- **Mughal Emperor Akbar**
3. When did British leave from EU? – **January, 2020**
4. Who is the only foreigner got the title 'birpratic' – **W.A.S. Ouderland**
5. Trump is **45th** president of USA.
6. In which fiscal year GDP growth rate of Bangladesh reaches seven percent- **(2015-2016)**
7. Which is considered as revenue? VAT/income tax/customs duty/all of the above.
8. Who is the president of India? – **Ram Nath Kobind**
9. What is the name of the Iranian general who is killed recently- **General Kasem Soleimani**
10. Which country's airplane recently Iran destroys? - **Ukraine**
11. Which country is the new member of NATO? – **Mecedonia**
12. COP-25 held in which country? – **Madrid, spain**
13. In which article of constitution separation of judiciary from executive is mentioned. – **22**
14. What is the synonym of stringent? – **Rigorous**
15. Opposite of transparent is – **opaque**
16. 'What can't be corrected' is called- **incorrigible**
17. put **into** order (couldn't remember fully)
18. A train went 300km from X to Y at an average speed of 100km/hr. At what speed did it travels on the way back if its average speed for the whole trip was 120Km/hr.- **150km/hr**
19. The ratio of boys and girls is 7:8. If the number of boys and girls increases 20% and 10% respectively then what will be the new ratio? -**21:22**
20. In a group of 15, 8 can speak Spanish, 7 can speak French and 3 can speak neither. What is the fraction of speaking both Spanish and French? – **1/5**
21. If white becomes black, red becomes yellow, green becomes blue and so on then what is the color of human blood? –**Yellow**
22. South-east becomes north and south becomes south-east. What will be direction for west if direction rotate likewise? **south-west**
23. Three boys have marbles in the ratio of 19:5:3. If the boy with the least number has 9 marbles, how many marbles does the boy with the highest number have? **57**
24. How many triangle is there?

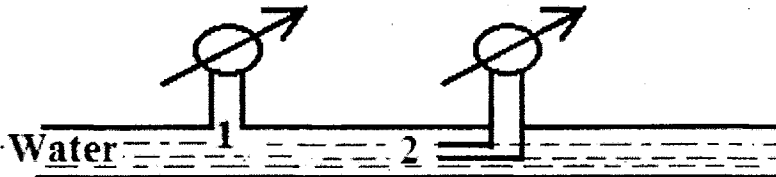


25. A water tank of length 25m width 9m and level of water in tank is 2m. if water is transferred in a cylinder of diameter 10m then what will be the level of water? $\frac{18}{\pi}$
26. Which mobile banking is not available in Bangladesh. -
27. Which African country first recognize Bangladesh as an independent country? **Senegal**

28. Ebola virus outbreak was shown in which country? **West Africa**
 29. Olympic 2020 will be held in which country? **Tokyo**
 30. Sudden fall down of barometer reading indicates **storm** and slowly fall down indicates **rainfall**.
 31. Gambia case against Myanmar in which court? **ICJ(International court of justice)**
 32. Which one is the element of pencil? **Graphite**
 33. Which element present in all kinds of acid? **Hydrogen**
 34. The luggage is **too heavy to lift**.
 35. Who is director of 'Muktir gan'. **Tarek Masud**
 36. If $a > b > 1$ then which one is correct? $a^2 > b^2$
 37. Which is not correct spelling? (options couldn't remember)
 38-40 সংগ্রহ করা সম্ভব হয়নি।

Departmental- $10 \times 6 = 60$

7. A pipe has inner diameter 50mm and two gauge pressures are 100 KPa and 97KPa. If the viscous loss is 0.5 m of water, find the flow rate inside the pipe.



Solution: Given that, $P_1 = 100\text{KPa}$; $P_2 = 97\text{KPa}$; $H_L = 0.5\text{m of water}$

We get, $\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + H_L$

$\Rightarrow \frac{V_1^2}{2g} = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + z_2 + H_L - \frac{P_1}{\gamma} - z_1$

$\Rightarrow \frac{V_1^2}{2g} = \frac{97 \times 10^3}{9.81 \times 10^3} + 0 + 0 + 0.5 - \frac{100 \times 10^3}{9.81 \times 10^3} - 0 = 0.1942$

$\Rightarrow V_1^2 = 3.81$

$\therefore V_1 = 1.952 \text{ m/s}$

$\therefore Q = AV_1 = \frac{\pi}{4} \times D^2 \times V_1 = \frac{\pi}{4} \times 0.05^2 \times 1.952 = 3.83 \times 10^{-3} \text{ m}^3 \text{ (Answer)}$

8. Draw the characteristic curve of centrifugal pump showing the system curve.
 [Same as BPDB-2018]

9. Cooling load of a vapour absorption refrigeration system is 2 TR and the COP is 3.5, find the amount of heat rejection?

Solution: Given, $Q_1 = 2 \text{ ton} = 2 \times 3.5 = 7\text{KW}$, Heat rejection to the condenser, $Q_2 = ?$

$\text{COP} = \frac{\text{cooling load}}{\text{work input}} = \frac{2 \times 3.5}{Q_2 - Q_1}$ or, $Q_2 - Q_1 = \frac{2 \times 3.5}{3.5} = 2$ so, $Q_2 = 7 + 2 = 9 \text{ KW (Answer)}$

4. Name four largest power plants in Bangladesh with their installed capacity.

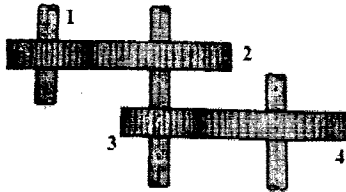
Answer:

Northwest Power Generation company Ltd.	3057MW
Ashuganj Power Station Company Ltd.	1690MW
Bangladesh-China Power Company (Pvt) Limited. (Payra)	1320MW
Electricity Generation Company of Bangladesh (EGCB) Ltd.	987MW

উপরের উত্তরে বিদ্যুৎ উৎপাদন কোম্পানীর নাম উল্লেখ করা হয়েছে। বাংলাদেশে এই মুহূর্তে অনেক কয়টি প্রকল্পের কাজ চলতেছে যেগুলোর উৎপাদন ক্ষমতা অনেক বেশি হবে। আবার প্রশ্নে কোন কোম্পানীর নাম চাওয়া হয়নি, বলা হয়েছে পাওয়ার প্ল্যান্টের নাম। সেক্ষেত্রে আমার মনে নামগুলো এই রকম হতে পারে।

Payra Thermal Power Plant	1320MW
Meghnaghat 450 MW CCPP (MPL)	450MW
Horipur 412 MW CCPP	412MW
Bibiana-3 CCPP 400 MW	400MW

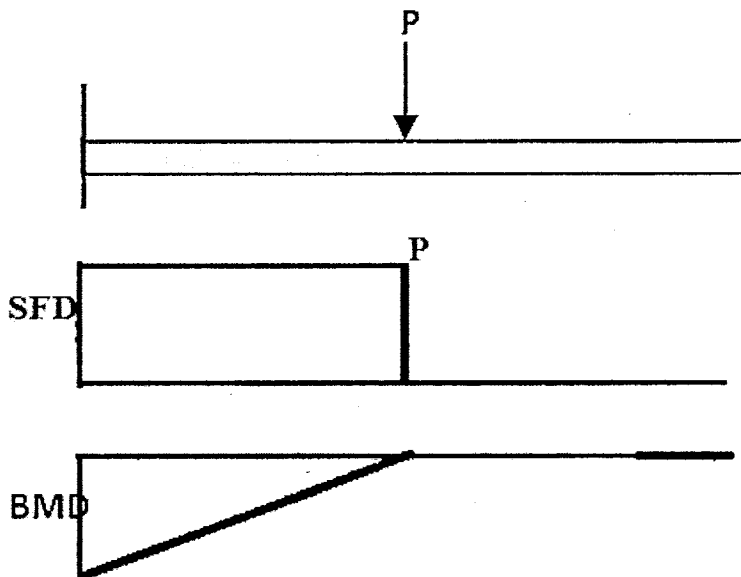
5. $T_1=40$, $T_2=50$, $T_3=60$, $T_4=20$ and $N_1=500\text{rpm}$ then $N_4=?$ [Similar]



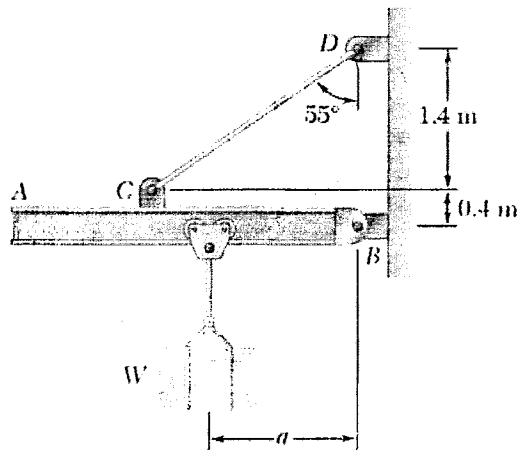
Solution:

$$\frac{N_1}{N_4} = \frac{T_2}{T_1} \times \frac{T_4}{T_3} \text{ or, } N_4 = \frac{T_1}{T_2} \times \frac{T_3}{T_4} \times N_1 = \frac{40 \times 60 \times 500}{50 \times 20} = 1200\text{rpm}$$

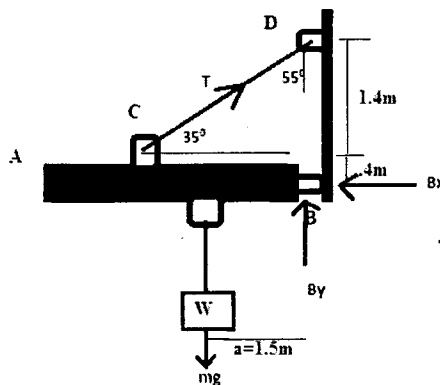
6. Draw the shear force and bending moment diagram.



7. A 50kg crate is attached to the trolley-beam system shown. Knowing that $a=1.5\text{m}$, determine (a) the tension in cable CD and (b) the reaction at B.



Solution:



$$\sum M_B = 0$$

$$\Rightarrow T \cos 35^\circ \times 0.4 + T \sin 35^\circ \times \frac{1.4}{\tan 35^\circ} - 50 \times 9.81 \times 1.5 = 0$$

$$\therefore T = 500.8\text{N (Answer)}$$

$$\sum F_x = 0$$

$$\therefore B_x = T \cos 35^\circ = 410.2\text{N}$$

$$\text{and } \sum F_y = 0$$

$$\therefore B_y = W - T \sin 35^\circ = 490.5 - 287.24 = 203.2\text{N}$$

$$\text{Reaction at B} = \sqrt{(B_x^2 + B_y^2)} = \sqrt{410.2^2 + 203.2^2} = 457.7\text{N} \angle \tan^{-1} \frac{203.2}{410.2} = 26.35^\circ$$

$$\therefore \text{Reaction at B} = 457.7\text{N} \angle 26.35^\circ \text{ (Answer)}$$

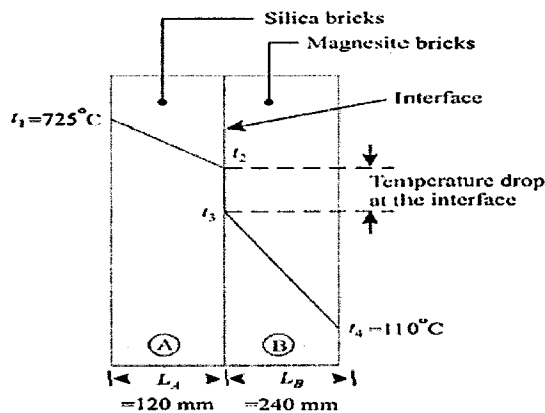
8. Two spring having stiffness of 10N/mm and 15N/mm respectively. If they are connected in series then what will be the resulting stiffness of the springs.

Solution:

$$\frac{1}{K_e} = \frac{1}{K_1} + \frac{1}{K_2} = \frac{1}{10} + \frac{1}{15}$$

$\therefore K_e = 6 \text{ N/mm}$ (Answer)

9. A wall of a furnace is made up of inside layer of silica brick 120 mm thick covered with a layer of magnesite brick 240mm thick. The temperatures at the inside surface of silica brick wall and outside surface of magnesite brick wall are 725°C and 110°C respectively. The contact thermal resistance between the two walls at the interface is 0.0035°C/W per unit wall area. If thermal conductivities of silica and magnesite bricks are $1.7 \text{ W/m}^\circ\text{C}$ and $5.8 \text{ W/m}^\circ\text{C}$, calculate the rate of heat loss per unit area of walls.



Figure

Solution: Given,

$$L_A = 120 \text{ mm} = 0.12 \text{ m}$$

$$L_B = 240 \text{ mm} = 0.24 \text{ m}$$

$$k_A = 1.7 \text{ W/m}^\circ\text{C}; k_B = 5.8 \text{ W/m}^\circ\text{C}$$

$$\text{The contact thermal resistance } (R_{th})_{cont.} = 0.0035^\circ\text{C/W}$$

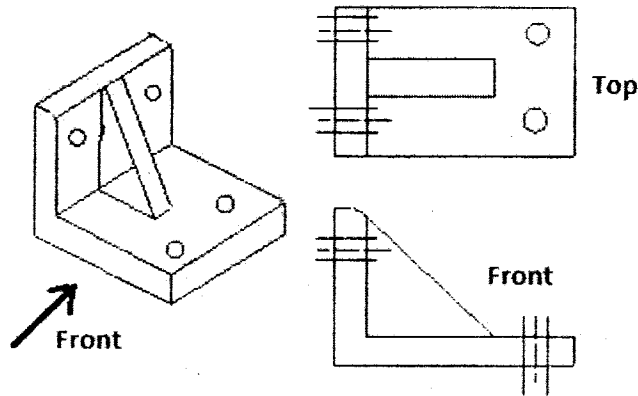
$$\text{The temperature at the inside surface of silica brick wall, } t_1 = 725^\circ\text{C}$$

$$\text{The temperature at the outside surface of the magnesite brick wall, } t_4 = 110^\circ\text{C}$$

ii) The rate of heat loss per unit area of wall, q :

$$\begin{aligned} q &= \frac{\Delta t}{\sum R_{th}} = \frac{\Delta t}{R_{th-A} + (R_{th})_{cont.} + R_{th-B}} \\ &= \frac{(t_1 - t_4)}{L_A/k_A + 0.0035 + L_B/k_B} \\ &= \frac{(725 - 110)}{0.12/1.7 + 0.0035 + 0.24/5.8} \\ &= \frac{615}{0.0706 + 0.0035 + 0.0414} \\ &= 5324.67 \text{ W/m}^2 \end{aligned}$$

\therefore The rate of heat loss per unit area of wall, $q = 5324.67 \text{ W/m}^2$

10. Draw the TOP and FRONT View.**Bangladesh Water Development Board (BWDB)****Post: Assistant Engineer(Mechanical)****Time-10.00AM to 11.30AM****Date:13.11.2020****[Marks Distribution: Departmental (ME+EEE)-40 Non Departmental-30]****Departmental (MCQ-30)**

- Air resistance for car at 20kmph is R. For 40kmph air resistance? **Ans- 4R**
[$R=KAV^2$ where K=co-efficient of air resistance, A=projected area of vehicle, V= vehicle speed.]
- What is the cooling capacity ordinary passenger aircraft? **Ans-8TR**
- The ratio of endurance limit in shear to endurance limit in flexure is ? **Ans-.55**
- Camshaft of a four stroke engine running at 1500rpm will run at ? **Ans- 750rpm**
- Poisson ratio = $\frac{\text{lateral strain}}{\text{linear strain}} = 1/m$
- The ratio of length and width of an arrow head -**3:1.**
- Maximum carbon content of steel can be-**1.5%**
- The primary winding of 220/6 V, 50Hz transformer is energized from 110V, 60Hz supply. The secondary output voltage will be -**3V.**
- What will be the emf generated by a 4-pole lap wound dc shunt motor rotates at the speed of 1500rpm has a flux of .4mWb and the total number of conduction are 1000.
Ans-10V
- A single phase full bridge diode rectifier delivers a load current of 10amp, which is ripple free. Average and rms value of diode currents are=? **10A & 7.07A**

11. A trolley wire has 1kg per meter length. The ends of the wire are attached to two poles 20m apart. If horizontal tension is 1500kg, the deflection in the mid span=**5cm**
12. The total pressure on the surface of a sluice gate of 2m x 1m with its top 2m surface being .5m below the water level will be=**2000kg**
13. The rotor frequency for a 3phase , 1000rpm and 6pole induction motor with a slip of .04 is =**52.08Hz**

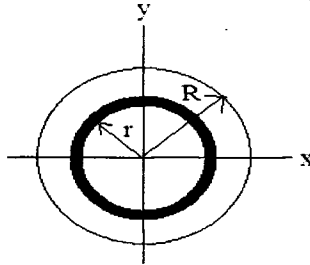
Non departmental

1. সন্ধি বিচ্ছেদ কর-বলুৎসব- বহিঃ+উৎসব
2. শরৎচন্দ্রের ছোটগল্প কোনটি?- মহেশ,বিলাসী,মামলার ফল
3. অহংকার পতনের মূল – অহংকার কোন কারকে কোন বিভক্তি। করণে শূন্য
4. বিধুর শব্দের অর্থ কি? কাতর
5. নিচের কোন ব্যক্তি বীরশ্রেষ্ঠ নন? আনিসুজ্জামান
6. বাংলাদেশকে প্রথম স্বীকৃতি দেয় কোন দেশ?ভুটান
7. মহয়া পালা গান কার লেখা?দ্বিজ কানাই
8. বাংলাদেশের প্রথম বাজেট পেশ করেন কে? তাজউদ্দিন আহমদ
9. কত টাকার নোটে গভর্ণরের স্বাক্ষর থাকে না? দুই টাকার নোটে
10. Which word is incorrect? **Conciencous/perseverance/convalescence/maintenance**
11. Find the correct sentence- **he is too clever not to miss the point/he is too clever to miss the point/he is too clever to grasp the point**

Departmental Written-40

1. Determine the centroidal polar moment of inertia of a circle of radius R.

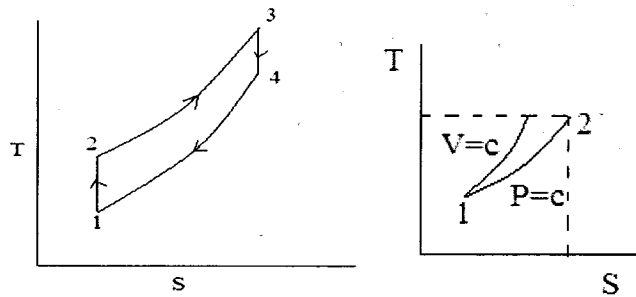
Solution: An annular differential element of area is chosen to be dA. Since all portions of the differential area are at the same distance from origin, we write



$$dJ = r^2 dA = r^2 (2\pi r dr)$$

$$J = \int_0^R dJ = \int_0^R r^2 (2\pi r) dr = \int_0^R 2\pi r^3 dr = \frac{\pi}{2} R^4 \text{ (Answer)}$$

2. Draw diesel cycle T-S diagram and prove that slope of the curve on T-S diagram for constant volume process is higher than constant pressure process.



For constant volume,

$$dQ = mC_v dT$$

$$\frac{dQ}{T} = \frac{mC_v dT}{T} \quad [\text{both side divided by } T]$$

$$dS = \frac{mC_v dT}{T} \quad \text{or, } \frac{dT}{ds} = \frac{T}{C_v} \quad \text{----- (1)}$$

For constant pressure,

$$dQ = mC_p dT$$

$$\frac{dQ}{T} = \frac{mC_p dT}{T} \quad [\text{both side divided by } T]$$

$$dS = \frac{mC_p dT}{T} \quad \text{or, } \frac{dT}{ds} = \frac{T}{C_p} \quad \text{----- (2)}$$

We know, $C_p > C_v$,

so from equation (1) and (2) $\frac{T}{C_v} > \frac{T}{C_p}$ or, $\left(\frac{dT}{ds}\right)_{V=\text{constant}} > \left(\frac{dT}{ds}\right)_{P=\text{constant}}$

Thus, the slope of constant volume is higher than the slope of constant pressure process. (Proved)

3. A centrifugal pump delivers $2.5 \text{ m}^3/\text{s}$ under a head of 14m and running at speed of 2010rpm. The impeller diameter of pump is 125mm. If a 104mm diameter impeller is fitted and the pump runs at speed of 2210rpm. What is the volume flow and head at new pump.

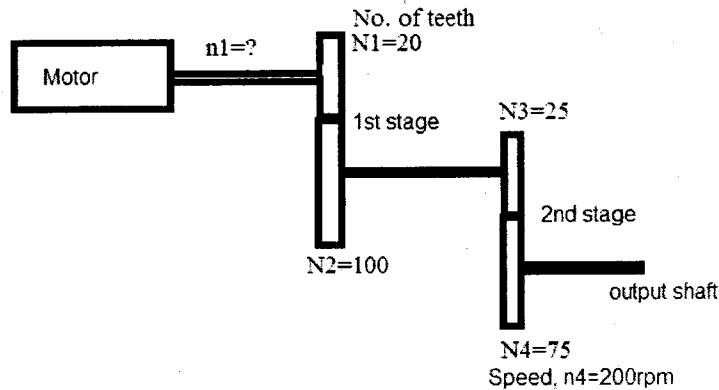
Solution:

Given, $Q_1 = 2.5 \text{ m}^3/\text{s}$, $N_1 = 2010 \text{ rpm}$, $H_1 = 14 \text{ m}$, $D_1 = 125 \text{ mm}$ and $D_2 = 104 \text{ mm}$, $N_2 = 2210 \text{ rpm}$, $Q_2 = ?$, $H_2 = ?$

$$\begin{aligned} \text{From similarity, } \frac{\sqrt{H_1}}{D_1 N_1} &= \frac{\sqrt{H_2}}{D_2 N_2} \quad \text{or, } H_2 = \left(\frac{D_2 N_2}{D_1 N_1}\right)^2 \times H_1 \\ &= \left(\frac{0.104 \times 2210}{0.125 \times 2010}\right)^2 \times 14 = 11.71 \text{ m (Answer)} \end{aligned}$$

$$\begin{aligned} \text{Again, } \frac{Q_1}{D_1^3 N_1} &= \frac{Q_2}{D_2^3 N_2} \quad \text{or, } Q_2 = \left(\frac{D_2}{D_1}\right)^3 \frac{N_2}{N_1} \times Q_1 \\ &= \left(\frac{0.104}{0.125}\right)^3 \times \frac{2210}{2010} \times 2.5 = 1.58 \text{ m}^3/\text{s (Answer)} \end{aligned}$$

4. A vehicle is driven from an electric motor via compound gear, where $N_1 = 20$, $N_2 = 100$, $N_3 = 25$, $N_4 = 75$. The efficiency of first stage is 94% and second stage is 96%. If the final drive requires a torque of 100Nm at 200rpm then determine the required torque and speed of the motor.

Solution:

Speed ratio,

$$\frac{n_1}{n_4} = \frac{N_2 \times N_4}{N_1 \times N_3} \text{ or, } n_1 = \frac{N_2 \times N_4}{N_1 \times N_3} \times n_4$$

$$= \frac{100 \times 75}{20 \times 25} \times 200 = 3000 \text{ rpm (Answer)}$$

From 2nd stage, $\eta_2 = \frac{P_2}{\text{Input power}}$

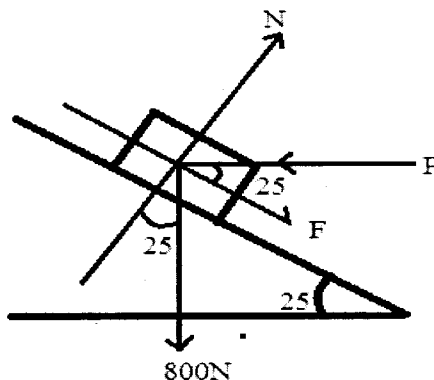
$$\text{or, Input power} = \frac{T\omega}{0.96} = \frac{100 \times 2\pi \times 200}{0.96 \times 60} = 2181.66 \text{ W}$$

This input power is output for the first stage.

$$\text{From 1st stage, } \eta_1 = \frac{\text{Output power}}{\text{Input power}} = \frac{2181.66}{P_1}$$

$$\text{or, } P_1 = \frac{2181.66}{0.94} = 2320.9 \text{ W}$$

$$\text{Torque required, } T = \frac{P_1}{\omega} = \frac{2320.9}{\frac{2\pi n_1}{60}} = 7.38 \text{ Nm (Answer)}$$

5. Determine P required (a) to start moving up the inclined surface.**(b) to keep it moving up.****Solution:** Given, $\mu_s = .35$, $\mu_k = .25$ 

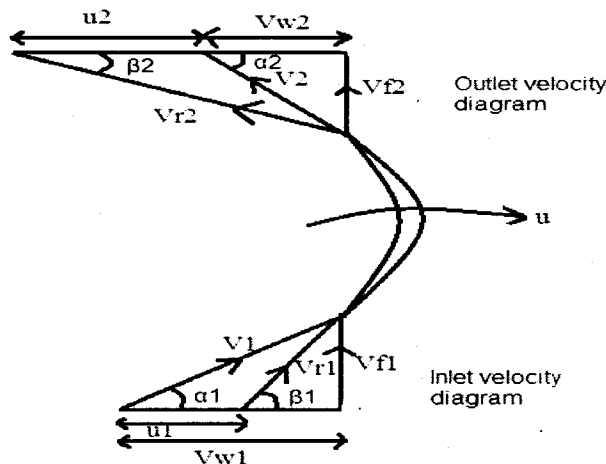
$$(a) \nearrow F_y = 0 \text{ or, } N = P \sin 25^\circ + 800 \cos 25^\circ \text{ -----(1)}$$

$$\begin{aligned} \Rightarrow F_x &= 0 \text{ or, } F + 800 \sin 25^\circ - P \cos 25^\circ = 0 \\ \text{or, } \mu_s N + 800 \sin 25^\circ - P \cos 25^\circ &= 0 \\ \text{or, } \mu_s (P \sin 25^\circ + 800 \cos 25^\circ) + 800 \sin 25^\circ - P \cos 25^\circ &= 0 \text{ [from equation (1)]} \\ P &= 780.4 \text{ N (Answer)} \end{aligned}$$

(b) Using μ_k instead of μ_s we get from above equation, $P = 739.2 \text{ N}$ (Answer)

6. In a reaction stage steam turbine the blade angle for stator and rotor of each stage, $\alpha_1 = 25^\circ$, $\beta_1 = 60^\circ$, $\alpha_2 = 71.1^\circ$, $\beta_2 = 32^\circ$. If blade velocity is 300 m/s and steam flow is 5 kg/s . Find out power developed, degree of reaction and axial thrust.

Solution:



$$P = F \times u = \dot{m} (V_{w1} + V_{w2}) \times u \text{ ----- (1)}$$

From inlet velocity diagram, $V_{f1} = V_1 \sin \alpha_1$, $V_{w1} = V_1 \cos \alpha_1$

$$\tan \beta_1 = \frac{V_{f1}}{V_{w1} - u_1} = \frac{V_1 \sin \alpha_1}{V_1 \cos \alpha_1 - 300} \text{ or, } V_1 = 453.26 \text{ m/s}$$

$$V_{w1} = V_1 \cos 25^\circ = 410.79 \text{ m/s ; } V_{f1} = V_1 \sin 25^\circ = 191.5 \text{ m/s ;}$$

$$V_{r1} = \frac{V_{f1}}{\sin \beta_1} = 221.18 \text{ m/s}$$

From outlet velocity diagram, $V_{f2} = V_2 \sin \alpha_2$, $V_{w2} = V_2 \cos \alpha_2$

$$\tan \beta_2 = \frac{V_{f2}}{V_{w2} + u_1} = \frac{V_2 \sin \alpha_2}{V_2 \cos \alpha_2 + 300} \text{ or, } V_2 = 252.07 \text{ m/s}$$

$$V_{w2} = V_2 \cos 71.1^\circ = 81.64 \text{ m/s ; } V_{f2} = V_2 \sin 71.1^\circ = 238.48 \text{ m/s ;}$$

$$V_{r2} = \frac{V_{f2}}{\sin \beta_2} = 450.03 \text{ m/s}$$

$$\text{Power developed, } P = F \times u = \dot{m} (V_{w1} + V_{w2}) \times u = 738645 \text{ W} = 738.64 \text{ KW (Answer)}$$

$$\text{Axial thrust, } F = \dot{m} (V_{f1} - V_{f2}) = 5 (238.48 - 191.5) = 234.9 \text{ N (Answer)}$$

$$\text{Degree of reaction} = \frac{(u_1^2 - u_2^2) + (V_{r2}^2 - V_{r1}^2)}{(u_1^2 - u_2^2) + (V_{r2}^2 - V_{r1}^2) + (V_1^2 - V_2^2)} = 0.52 \text{ (Answer)}$$

7. A 220 V shunt motor with an armature resistance of 0.5Ω is excited to give constant main field. At full load the motor runs at 500 rpm and takes an armature current of

30amp. If a resistance of 1Ω is placed in the armature circuit, find the speed at (a) full load torque (b) double full load torque.

Solution: $E_1 = V - I_A R_A = 220 - (0.5 \times 30) = 205V$

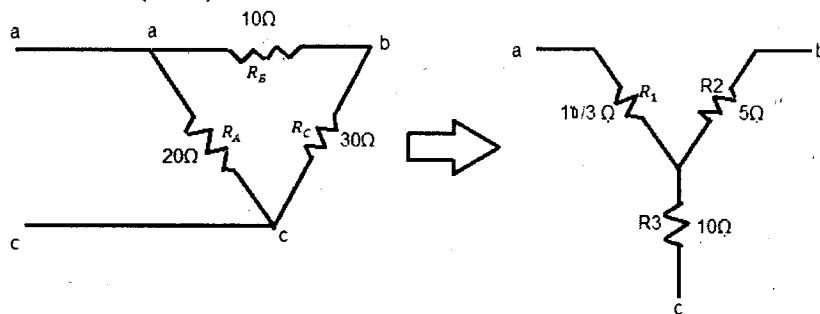
& $E_2 = V - I_A R_A = 220 - (0.5 + 1) \times 30 = 175V$

(a) $\frac{N_2}{N_1} = \frac{E_2}{E_1}$ or, $N_2 = \frac{500 \times 175}{205} = 426.8 \text{rpm} \approx 427 \text{rpm (Answer)}$

(b) $I_2 = 2I_1 = 2 \times 30 = 60 \text{amp}$ & $E_2 = 220 - (1.5 \times 60) = 130V$

$\frac{N_2}{N_1} = \frac{E_2}{E_1}$ or, $N_2 = \frac{500 \times 130}{205} = 317.7 \text{rpm (Answer)}$

8. Transform delta to Y(Star)

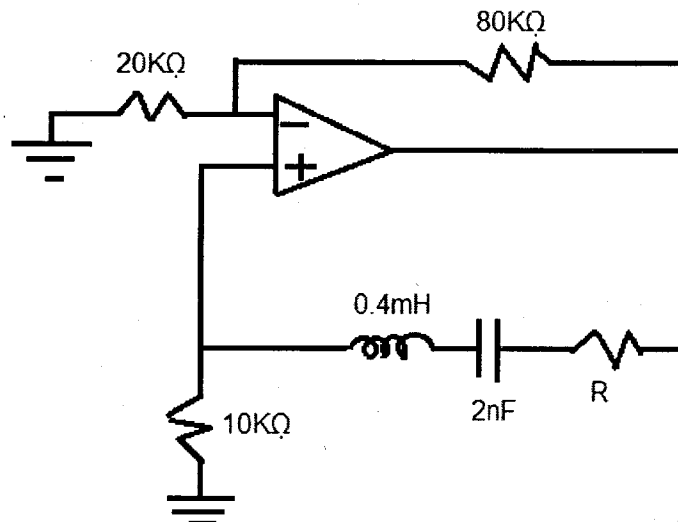


$$R_1 = \frac{R_A \times R_B}{R_A + R_B + R_C} = \frac{20 \times 10}{20 + 10 + 30} = \frac{10}{3} \Omega$$

$$R_2 = \frac{R_C \times R_B}{R_A + R_B + R_C} = \frac{30 \times 10}{20 + 10 + 30} = 5 \Omega$$

$$R_3 = \frac{R_C \times R_A}{R_A + R_B + R_C} = \frac{30 \times 20}{20 + 10 + 30} = 10 \Omega$$

9. Consider the oscillator in Fig. below (a) Determine the oscillation frequency. (b) Obtain the minimum value of R for which oscillation takes place.



(a)

Let V_2 = voltage at the noninverting terminal of the op amp V_o = output voltage of the op amp

$$Z_p = 10 \text{ k}\Omega = R_o$$

$$Z_s = R + j\omega L + \frac{1}{j\omega C}$$

We get,

$$\frac{V_2}{V_o} = \frac{Z_p}{Z_s + Z_p} = \frac{R_o}{R + R_o + j\omega L - \frac{j}{\omega C}}$$

$$\frac{V_2}{V_o} = \frac{\omega C R_o}{\omega C (R + R_o) + j(\omega^2 LC - 1)}$$

For this to be purely real,

$$\omega_o^2 LC - 1 = 0 \longrightarrow \omega_o = \frac{1}{\sqrt{LC}}$$

$$f_o = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(0.4 \times 10^{-3})(2 \times 10^{-9})}}$$

$$f_o = 180 \text{ kHz (Answer)}$$

(b) At oscillation,

$$\frac{V_2}{V_o} = \frac{\omega_o C R_o}{\omega_o C (R + R_o)} = \frac{R_o}{R + R_o}$$

This must be compensated for by

$$A_v = \frac{V_o}{V_2} = 1 + \frac{80}{20} = 5$$

$$\frac{R_o}{R + R_o} = \frac{1}{5}$$

$$R = 4R_o = 40 \text{ k}\Omega \text{ (Answer)}$$

10. A PMMC instrument with FSD of $100 \mu\text{A}$ and a coil resistance of $1 \text{ k}\Omega$ is to be converted into a voltmeter. Determine the required multiplier resistance if the voltmeter is to measure 50 V at full scale. Also, calculate the applied voltage when the instrument indicates 0.8 , 0.5 , and 0.2 of FSD. [Similar]

Solution:

$$V = I_m(R_s + R_m)$$

$$R_s + R_m = \frac{V}{I_m}$$

$$R_s = \frac{V}{I_m} - R_m$$

For $V = 50 \text{ V}$, FSD,

$$I_m = 100 \mu\text{A}$$

$$R_s = \frac{50 \text{ V}}{100 \mu\text{A}} - 1 \text{ k}\Omega$$

$$= 499 \text{ k}\Omega$$

$$\text{At } 0.8 \text{ FSD, } I_m = 0.8 \times 100 \mu\text{A} = 80 \mu\text{A}$$

$$V = I_m(R_s + R_m)$$

$$= 80 \mu\text{A}(499 \text{ k}\Omega + 1 \text{ k}\Omega) = 40 \text{ V}$$

$$\text{At } 0.5 \text{ FSD, } I_m = 0.5 \times 100 \mu\text{A} = 50 \mu\text{A}$$

$$V = I_m(R_s + R_m)$$

$$= 50 \mu\text{A}(499 \text{ k}\Omega + 1 \text{ k}\Omega) = 25 \text{ V}$$

$$\text{At } 0.2 \text{ FSD, } I_m = 0.2 \times 100 \mu\text{A} = 20 \mu\text{A}$$

$$V = I_m(R_s + R_m)$$

$$= 20 \mu\text{A}(499 \text{ k}\Omega + 1 \text{ k}\Omega) = 10 \text{ V}$$

Dhaka North City Corporation (DNCC)

Post: Assistant Engineer (Mechanical)

Exam Venue: BUET

Date: 29.11.2020

Departmental- 10×6=60

10. Draw the typical characteristic curve of centrifugal pump showing the design/duty point.

Answer: [Same as BPDB-2018; ERL-2017, BITAC-2021]

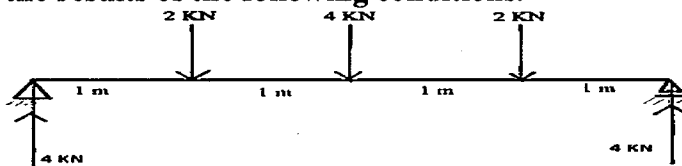
2. Draw a block diagram of a steam turbine power plant only with the four elements. Draw the corresponding T-S diagram.

Answer: Same as NPCBL-2017

3. A hydroelectric pump is used to lift water which has a suction head of 1.6m and delivery head of 17.4m. Discharge of this pump is $60\text{m}^3/\text{h}$. Determine the power of the motor if the combined efficiency of the drive motor and the pump is 70%.

Solution: Same as NPCBL-2017

4. Write down the results of the following conditions.



Solution: Same as Titas Gas Transmission and Distribution Company Limited- 2018

5. Draw the load vs. deflection curve for the following materials: rubber, cast iron and mild steel in a tension test.

Answer: Same as Titas Gas Transmission and Distribution Company Limited- 2018

6. Write down the Equation of thin walled pressure vessel-

a) Longitudinal stress

b) Hoop stress

c) Criteria for being thin walled pressure vessel

Solution: (a) Longitudinal stress, $\sigma_L = \frac{PD}{4t}$

(b) Hoop/ Tangential stress, $\sigma_t = \frac{PD}{2t}$

(c) Criteria for being thin walled pressure vessel: By the definition of thin wall pressure vessel, $t = \frac{D}{15}$ or, $\frac{D}{20}$ or, $\frac{D}{10}$

7. In a pipe flow $Nu = 0.248 Re^{0.612} Pr^{1/3}$. Write down the equation for Nu, Re and Pr number. [Similar]

Answer: $Nu = \frac{hD}{K}$; $Re = \frac{\rho VD}{\mu}$; $Pr = \frac{\mu C_p}{K}$

[বাকি তিনটি প্রশ্ন সংগ্রহ করা সম্ভব হয়নি।]

Non-Departmental- 40

1. প্রাকৃত শব্দের অর্থ কি?
a. প্রকৃত b. যথার্থ c. যা করা হয়েছে d. স্বাভাবিক
2. কোন সময়কে বাংলা সাহিত্যের অন্ধকার যুগ বলা হয়?
a. ১২০১-১৩৫০ খ্রিষ্টাব্দ b. ৬০০-৯৫০ খ্রিষ্টাব্দ c. ১৩৫১-১৫০০ খ্রিষ্টাব্দ d. ৬০০-৭৫০ খ্রিষ্টাব্দ
3. নিচের কোনটি ভুল বানান?
a. পলল b. মুহ্যমান c. প্রজ্জ্বলন d. নৈঋত
4. 'বামেতর' শব্দটির অর্থ- a. বামচোখ b. ডান c. ইতর d. বাম দিক
5. কোন বাক্যে 'মাথা' শব্দটি বুদ্ধি অর্থে ব্যবহৃত হয়?
a. তিনিই সমাজের মাথা b. মাথা খাটিয়ে কাজ করবে c. লজ্জায় মাথা কাটা গেল d. মাথা নেই তার মাথা ব্যথা
6. উপরি + উক্ত সন্ধিবদ্ধ শব্দ কোনটি? a. উপরিউক্ত b. উপর্যপরি c. উপর্যুক্ত d. পুনরপি
7. The range of normal human hearing is in the range of
a. 10 Hz to 80 Hz b. 50 Hz to 80 Hz c. 50Hz to 15000 Hz d. 15000 Hz and above
8. Who has called Bangabandhu the "Poet of Politics"? - **Newsweek magazine**
9. Who is the architect of national monument? - **Syed Mainul Hossain**
10. The heat of sun reaches to us according to-
a. Conduction b. Convection c. **Radiation** d. None of these
11. Which among the following vitamins is absent in an egg? - **Vitamin C**
12. Which date is the Six Point Movement Day? - 7th June
13. How many Bir Uttam awarded for liberation war of Bangladesh? - 69
14. Who gave first corona test kit to Bangladesh?
15. Which one is the elaboration of VIRUS: **Vital Information Resources Under Seize.**
16. Which one is related with stroke? - a. head b. **heart** c. liver [Answer is not sure]
17. The recent updated environmental protocol- a. Kyoto b. Montreal c. **Paris**
18. What will be the GDP of Bangladesh in 2021? - **338.39\$**
19. The average marks of four subjects is 120. If 33 was misread as 13 during the calculation, what will be the correct average?
a. 122 b. 120 c. **125** d. 121
20. 66 cubic centimetres of silver is drawn into a wire 1 mm in diameter. The length of the wire in metres will be
a. **84m** b. 90m c. 168m d. 336m
21. The diagonal of a rectangle is $\sqrt{41}$ cm and its area is 20 sq. cm. The perimeter of the rectangle must be:
a. 9 cm b. **18 cm** c. 20 cm d. 41 cm
22. The value of $(1+\frac{1}{x})(1+\frac{1}{x+1})(1+\frac{1}{x+2})(1+\frac{1}{x+3})$ is?
a. $1+\frac{1}{x+4}$ b. $x+4$ c. $\frac{1}{x}$ d. $\frac{x+4}{x}$

23. If a man were to sell his chair for Tk.. 720, he would lose 25%. To gain 25% he should sell it for:

a. Tk. 1,200 b. Tk. 1,000 c. Tk. 960 d. Tk. 900

24. If $\frac{2}{3}$ of A=75% of B = 0.6 of C, then A : B : C is

a. 2 : 3 : 3 b. 3 : 4 : 5 c. 4 : 5 : 6 d. 9 : 8 : 10

25. I'm afraid I took your umbrella by _____.

a. fault b. error c. misdeed d. mistake

[বাকি প্রশ্নগুলো সংগ্রহ করা সম্ভব হয়নি।]

RPCL-Norinco Intl. Power Limited (RNPL)

Post: Assistant Engineer(Mechanical)

Time- One and half hours

Date:19.12.2020

[Marks: 100(MCQ)]

1. Compression ratio of petrol engine-6 to 10
2. What is used for proper and safe functioning of boiler –boiler mountings.
3. Purpose of economizer of a boiler- to heat the feed water by using flue gas.
4. Purpose of super heater of a boiler- to dry the steam so that there is no moisture in steam
5. In spark ignition engine, how to reduce knocking?- by reducing the compression ratio, retarding the spark, increasing the engine speed.
6. Air refrigeration system used in- gas liquefaction
7. Ton of refrigeration- one tonne of ice melts from and at 0°C in 24hours, the refrigeration effect is equivalent to 210kj/min
8. Only hydroelectric power plant in Bangladesh- Karnafuli hydroelectric power plant, kaptai
9. Champion of the earth 2020-Frank Bainimarama, Dr. Fabian Leendertz, Mindy lubber, Nemonte Nenquimo and Yacouba Sawadogo
10. Latest champion of T20 cricket world cup (men)?- west indies
11. Value of reheat factor-1.02 to 1.06
12. Function of steam stop valve- to shut off or regulate the flow of steam from boiler to the steam pipe
13. Type of coal used in cement and metallurgical industry-bituminous coals
14. At which temperature natural gas is converted into LNG at atmospheric pressure- - 162°C
15. Carbon percentage in cast iron- 1.7 to 4.5%
16. Gear size is specified by- pitch circle diameter

17. Steam turbine is classified according to –steam action/stage number/steam flow direction/**all**
18. Cavitation occurs in – reciprocating pump/axial flow pump/steam pump/power pump
19. Brayton cycle efficiency-more/**less**/equal to carnot cycle
20. Which is the upper cycle of CCPP- **Gas turbine**
21. Which is positive displacement pump- mixed flow/centrifugal/**rotary vane pump**
22. At which velocity the flow becomes turbulent from laminar-
critical/sonic/supersonic/ultrasonic
23. What device is used to rise the temperature of steam without increasing pressure-
super heater
24. Psychometric chart indicates property of –dry air/**moist air**/water/water vapor
25. Main property considered for refrigerant- **low boiling point**
26. Which iron is used for ball bearing- **chromium steel**
27. Function of nozzle- **to convert pressure energy into kinetic energy**
28. Use of FGD plant- **Flue gas desulfurization**
29. Purpose of engine transmission- **to control the speed and torque**
30. If flow is perpendicular to the shaft then what type of pump it is- **radial flow pump**
31. Function of high octane number- **to reduce knocking**
32. Constituents of LPG- **butane and propane**
33. Reynolds number- **ratio of inertia force to the viscous force**
34. In which cycle closed cycle gas turbine is worked- **joule cycle**
35. Hindrance means- **obstruction/resistance**
36. ‘By and large’ means- **on the whole/everything considered**
37. Who got Nobel prize 2020 in literature-**Louise gluck**
38. If 45000tk is invested at 90tk per share and 30000tk is invested at 60tk per share,
what is average investment per share-
39. Most ancient place of Bangladesh- **mohasthanagar**
40. ‘Let there be light’ written by-**Dan Gordon and Sam Sorbo**
41. State minister power, energy and mineral resource of Bangladesh- **Nasrul Hamid**
42. Mujib year- **17 march 2020 to 16 December, 2021**
43. ‘পোস্টমাস্টার’ রবীন্দ্রনাথ ঠাকুরের কি ধরনের রচনা? সামাজিক ছোট গল্প
44. বাংলা প্রথম কাব্য সংকলন- **চর্যাপদ**
45. আইন প্রণয়নের ক্ষমতা- **জাতীয় সংসদের**
46. কাজী নজরুল ইসলামের প্রথম কাব্যগ্রন্থ- **অগ্নিবীণা**
47. শুদ্ধ বানান- **দীনতা/দৈনতা/দুরাবস্থা**

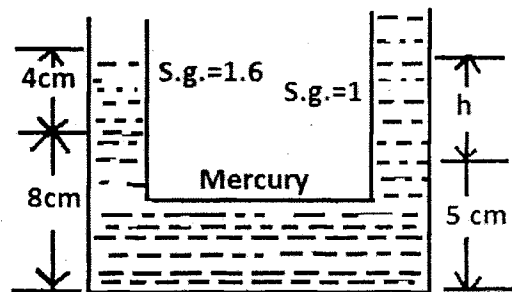
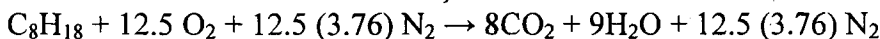
Dhaka Power Distribution Company Limited (DPDC)
Post: Assistant Engineer in "G2G" project on a temporary basis
Exam Venue: BUET
Date: 18.12.2020

11. Find the value of h?**Solution:**

We get,

$$4 \times 1.6 + 8 \times 13.6 = h \times 1 + 5 \times 13.6$$

$$\Rightarrow h = 47.6 \text{ cm (Answer)}$$

**12. Isooctane is burned with 120% theoretical air in small three cylinder turbocharged automobile engine. Calculate Air Fuel ratio.****Solution:** Stoichiometric reaction,

With 20% excess air,



$$\text{Air-Fuel ratio} = \frac{A}{F} = \frac{M_a}{m_f} = \frac{N_a M_a}{N_f M_f} = \frac{15 \times 4.76 \times 29}{1 \times 114} = 18.16 \text{ (Ans.)}$$

13. Bsfc of a diesel engine is 240g/KW hr. Calculate diesel consumption rate in litre/hr.**Electric load is 30KW and alternator efficiency is 90%. (s.gr. 0.85)****Solution:**

[Here, Electric load = alternator output; alternator input = Brake power]

$$\text{We get, alternator efficiency, } \eta_{al} = \frac{\text{Electrical load}}{\text{Brake power}}; \Rightarrow \text{Brake power} = \frac{30}{0.9} = 33.33 \text{ KW}$$

$$\text{Bsfc} = \frac{\dot{m}_f}{\text{brake power}}; \Rightarrow \dot{m}_f = 33.33 \times 240 \frac{\text{g} \times \text{KW}}{\text{KW hr}} = 8000 \frac{\text{g}}{\text{hr}} = 8 \text{ Kg/hr}$$

$$\therefore \dot{V}_f = \frac{8}{0.85 \times 1000} = 9.41 \times 10^{-3} \text{ m}^3/\text{hr} = 9.41 \text{ litre/hr (Answer)}$$

14. A 5 Ton refrigeration system consumes 3.75 kW find the EER. If enthalpy change in evaporator is 56 KJ per unit mass. Find mass flow rate.**Solution:** Given, Refrigeration Effect = 5TR = $5 \times 3.5 \text{ KW} = 17.5 \text{ KW} = 60000 \text{ BTU/hr}$
[1 Ton = 12000 BTU/hr]

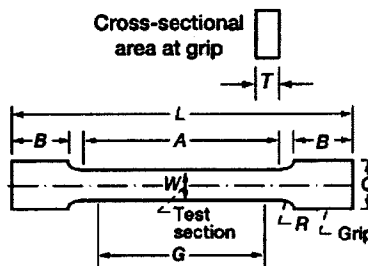
$$\text{EER} = \frac{\text{Refrigeration Effect (BTU/hr)}}{\text{Power input (W)}} = \frac{60000}{3.75 \times 1000} = 16 \text{ (Answer)}$$

We get, Refrigerant effect = Mass flow rate \times Change of Enthalpy

$$\therefore \text{Mass flow rate} = \frac{\text{Refrigerant effect}}{\text{Change of Enthalpy}} = \frac{17.5}{56} = 0.3125 \text{ Kg/s (Answer)}$$

15. A rectangular test bar specimen is subjected to tension test. Test result shows:— thickness at the grip is 6mm, width inside the gauge section is 40mm, gauge length

200 mm, Yield load 225KN, braking load 242 KN, final length after elongation 249 mm. Find the Tensile strength and percent of elongation? [similar]



Solution: Given that, $t = 6$ mm, width = 40mm, $L = 600$ mm, Gauge length, $L_g = 200$ mm, Braking load = 242 KN, Final length after elongation, $L_e = 249$ mm

$$\begin{aligned} \text{We get, Tensile strength} &= \frac{\text{Yield load}}{\text{Cross sectional area in the gauge section, } A_G} = \frac{\text{Yield load}}{\text{width} \times \text{thickness}} \\ &= \frac{225 \times 1000}{40 \times 6} \\ &= 937.5 \text{ MPa (Answer)} \end{aligned}$$

$$\text{Again, Percentage of elongation} = \frac{L_e - L_g}{L_g} = \frac{249 - 200}{200} = 24.5\% \text{ (Answer)}$$

Reference Book: Strength of Materials by Surya N. Patnaik & Dale A. Hopkins

16. Two parallel shafts, about 600 mm apart are to be connected by spur gears. One shaft is to run at 360 r.p.m and the other at 120 r.p.m. If the circular pitch is to be 25 mm, determine the teeth of each gear.

Solution:

Given, $x = 600$ mm; $N_1 = 360$ r.p.m; $N_2 = 120$ r.p.m; $P_c = 25$ mm

Let, d_1 = Pitch circle diameter of the first gear

d_2 = Pitch circle diameter of the second gear

We know that the speed ratio,

$$\frac{N_1}{N_2} = \frac{d_2}{d_1} = \frac{360}{120} = 3 \text{ or, } d_2 = 3d_1 \dots \dots \dots (1)$$

And center distance between the shafts (x),

$$600 = \frac{1}{2} (d_1 + d_2)$$

$$\text{or, } d_1 + d_2 = 1200 \dots \dots \dots (2)$$

From equations (1) and (2), we find that

$d_1 = 300$ mm, and $d_2 = 900$ mm

Number of teeth on the first gear,

$$T_1 = \frac{\pi d_1}{P_c} = \frac{\pi \times 300}{25} = 37.7$$

And the number of teeth on the second gear,

$$T_2 = \frac{\pi d_2}{P_c} = \frac{\pi \times 900}{25} = 113.1$$

Since the numbers of teeth on both gears are to be in complete numbers, therefore let us make the number of teeth on the first gear as 38. (Answer)

Therefore for a speed ratio of 3, the number of teeth on the second gear should be $38 \times 3 = 114$ (Answer)

17. 2 Litres of water from 28°C is to be heated in an electric kettle that consumes 1.5 KW load. If final temperature is 80°C, determine the time required. What will be the cost if power per unit electricity consumption charge is 12 taka?

Solution: We get,

$$ms\Delta\theta = \text{Power} \times \text{Time}$$

$$\Rightarrow \text{Time} = \frac{ms\Delta\theta}{\text{Power}}$$

$$\Rightarrow \text{Time} = \frac{2 \times 4.2 \times (80 - 20)}{1.5} = 336 \text{ sec} = 5.6 \text{ min (Answer)}$$

$$\text{Total Power Consumption} = \text{Power} \times \text{Time} = 1.5 \text{ KW} \times 0.093 \text{ hr} = 0.14 \text{ KW-hr}$$

$$\therefore \text{Cost} = 12 \times 0.14 = 1.68 \text{ taka (Answer)}$$

18. A thin walled cylindrical tank with vertical axis is fully filled with water of 25 m and ID is 2.2 m. The tank is opened in atmosphere. Find out the minimum thickness of the tank. The yield and ultimate strength are 210 and 380 MN/mm². Factor of safety 3.

Solution:

As the tank material is unknown then we can consider the Ultimate stress,

$$\text{Working stress, } \sigma_w = \frac{\sigma_{ul}}{N} = \frac{380}{3} = 126.67 \text{ MN/m}^2$$

$$\begin{aligned} \text{Pressure at the base, } p &= wh \\ &= 10 \times 10^3 \times 25 \times 10^{-6} \text{ MN/m}^2 \\ &= 0.25 \text{ MN/m}^2 \end{aligned}$$

$$\text{We know, } \sigma_c = \frac{pd}{2t}$$

$$\Rightarrow 126.67 \times 10^6 = \frac{0.25 \times 10^6 \times 2.2}{2 \times t}$$

$$\begin{aligned} \therefore t &= \frac{0.25 \times 10^6 \times 2.2}{2 \times 126.67 \times 10^6} \\ &= 0.00217 \text{ m} \\ &\approx 2.17 \text{ mm} \end{aligned}$$

If the tank material is steel, then

$$\text{Working stress, } \sigma_w = \frac{\sigma_{yp}}{N} = \frac{210}{3} = 70 \text{ MN/m}^2$$

$$\begin{aligned} \text{Pressure at the base, } p &= wh \\ &= 10 \times 10^3 \times 25 \times 10^{-6} \text{ MN/m}^2 \\ &= 0.25 \text{ MN/m}^2 \end{aligned}$$

$$\text{We know, } \sigma_c = \frac{pd}{2t}$$

$$\Rightarrow 70 \times 10^6 = \frac{0.25 \times 10^6 \times 2.2}{2 \times t}$$

$$\therefore t = \frac{0.25 \times 10^6 \times 2.2}{2 \times 70 \times 10^6}$$

$$= 0.0039 \text{ m}$$

$$\approx 4 \text{ mm}$$

\therefore The minimum thickness of the tank is 4 mm (Answer)

From equation 2-2 of book "Strength of Materials- Ferdinand L. Singer & Andrew Pytel" Factor of Safety and working stress

$$\sigma_w = \frac{\sigma_{yp}}{N}; \text{ or } \sigma_w = \frac{\sigma_{ult}}{N}$$

The **yield point** is selected as the basis for determining σ_w in structural steel because it is the stress at which a prohibitively large permanent set may occur. **For other materials**, the allowable stress is usually based on the **ultimate strength**.

Problem: A cylindrical water tank of height 25m, inside diameter 2.2 m, having vertical axis is open at the top. The tank is made of steel having yield stress of 210 MN/m^2 . Determine the thickness of steel used when the tank is full of water. Given: Efficiency of the longitudinal joint = 70 %; Factor of safety = 3

[Example 10.4. Book: Strength of Materials (Mechanics of Solids)- Er. R.K. Rajput]

Solution:

$$\text{Working stress, } \sigma_w = \frac{\sigma_{yp}}{N} = \frac{210}{3} \\ = 70 \text{ MN/m}^2$$

The pressure will be *maximum at the base*. This pressure must be resisted by steel sheet and therefore the thickness must be determined by taking the maximum pressure into consideration.

$$\text{Pressure at the base, } p = wh \\ = 10 \times 10^3 \times 25 \times 10^{-6} \text{ MN/m}^2 \\ = 0.25 \text{ MN/m}^2$$

Since the tank is open at the top, there will only be hoop (or circumferential) stress which, under any circumstances, should not exceed the working stress.

$$\text{We know, } \sigma_c = \frac{pd}{2t\eta_l} \\ \Rightarrow 70 \times 10^6 = \frac{0.25 \times 10^6 \times 2.2}{2 \times t \times 0.7}$$

$$\therefore t = \frac{0.25 \times 10^6 \times 2.2}{2 \times 70 \times 10^6 \times 0.7} \\ = 0.0056 \text{ m}$$

$$\approx 6 \text{ mm (Answer)}$$

Problem: A cylinder of thickness 1.5cm, has to withstand maximum internal pressure of 1.5 N/mm^2 . If the ultimate tensile stress in the material of the cylinder is 300 N/mm^2 , factor of safety 3.0 and joint efficiency 80%, determine the diameter of the cylinder.

[Example 17.8. Book: A text book of Strength of Materials - Dr. R.K. Bansal]

Solution: Given,

Thickness of cylinder, $t = 1.5 \text{ cm}$

Internal pressure, $P = 1.5 \text{ N/mm}^2$

Ultimate tensile stress = 300 N/mm^2

Factor of safety = 3.0

$$\therefore \text{Working stress, } \sigma_w = \frac{\sigma_{ul}}{N} = \frac{300}{3} \\ = 100 \text{ N/mm}^2$$

Joint efficiency, $\eta = 80\% = 0.8$

The stress corresponding to longitudinal joint is given by,

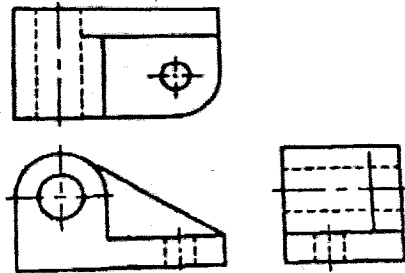
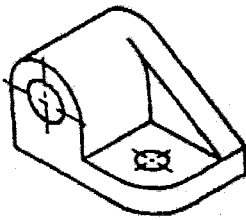
$$\sigma_l = \frac{pd}{2t\eta_l} \\ \Rightarrow 100 = \frac{1.5 \times d}{2 \times 1.5 \times 0.8} \\ \therefore d = \frac{100 \times 2 \times 1.5 \times 0.8}{1.5} \\ = 160 \text{ cm} = 1.6 \text{ m (Answer)}$$

19. A pipe has inner diameter 50mm and two gauge pressures are 100 KPa and 97KPa.

If the viscous loss is 0.5 m of water, find the flow rate inside the pipe.

Solution: Same as BPDB-2018

10) Draw the TOP & FRONT View.



Sundarban Gas Company Limited (SGCL)

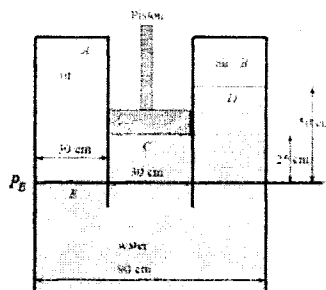
Date: 10.12.2020

Exam Hall: BUET

Departmental: $8 \times 5 = 40$; Non-dept.: $30 \times \frac{2}{3} = 20$

[Math + Analytical = 10; GK = 10; = 5; Bangla = 5]

1. Two chambers with the same fluid at their base are separated by a piston whose weight is 25 N, as shown. Calculate the gage pressures in chambers A and B.



Solution:

Here, $P_A = P_E$

$$P_E = 1000 \times 9.81 \times 0.5 + P_B$$

Again,

$$P_E = \rho g \times 0.25 + \frac{W}{A_{\text{piston}}}$$

$$\Rightarrow P_E = 1000 \times 9.81 \times 0.25 + \frac{25}{\pi \times \frac{0.3^2}{4}}$$

$$\Rightarrow P_E = 2806 \text{ Pa}$$

$$\therefore P_A = 2806 \text{ Pa (Answer)}$$

Then,

$$P_B = 2806 - 1000 \times 9.81 \times 0.5$$

$$= -2099 \text{ Pa (Answer)}$$

2. Consider a 0.8-m-high and 1.5-m-wide glass window with a thickness of 8 mm and a thermal conductivity of $k = 0.78 \text{ W/m}^\circ\text{C}$. Determine the steady rate of heat transfer through this glass window and the temperature of its inner surface for a day during

which the room is maintained at 20°C while the temperature of the outdoors is 10°C . Take the heat transfer coefficients on the inner and outer surfaces of the window to be $h_1=10 \text{ W/m}^2\cdot^\circ\text{C}$ and $h_2=40 \text{ W/m}^2\cdot^\circ\text{C}$, which includes the effects of radiation.

Solution:

$$Q = \frac{T_i - T_o}{\frac{1}{h_1 A} + \frac{L}{KA} + \frac{1}{h_2 A}} = \frac{20 - (-10)}{\frac{1}{10 \times 1.2} + \frac{0.008}{0.78 \times 1.2} + \frac{1}{40 \times 1.2}}$$

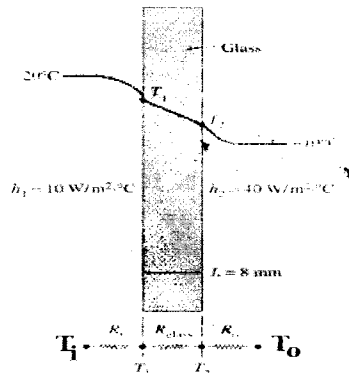
$$= 226 \text{ W (Answer)}$$

The inner surface temperature of the window glass can be determined from

$$Q = \frac{T_i - T_1}{\frac{1}{h_1 A}} = \frac{20 - T_1}{\frac{1}{10 \times 1.2}}$$

$$\Rightarrow 226 = \frac{20 - T_1}{0.08333}$$

$$\Rightarrow T_1 = -2.2^\circ\text{C (Answer)}$$



3. Water is pumped to a tank 18m high at a rate of 70 L/s by a pump whose motor consumes 20.4 kW power. The diameter of the delivery pipe is 150 mm. Find the overall efficiency of the combined pump-motor system, considering no frictional loss. (Similar)

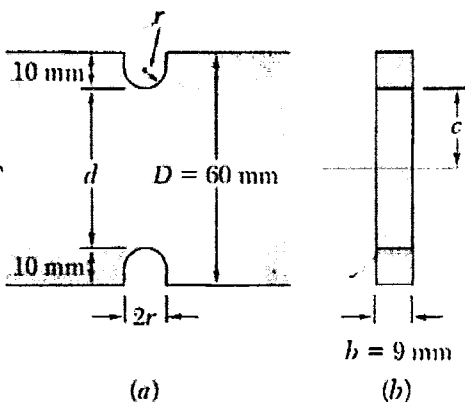
Solution: We get, $Q = AV$; $V = \frac{Q}{A} = \frac{0.07}{\pi(0.075)^2} = 3.96 \text{ m/s}$

$$\therefore H = 18 + \frac{V^2}{2g} = 18 + \frac{(3.96)^2}{2 \times 9.81} = 18.80 \text{ m (Considering no frictional loss)}$$

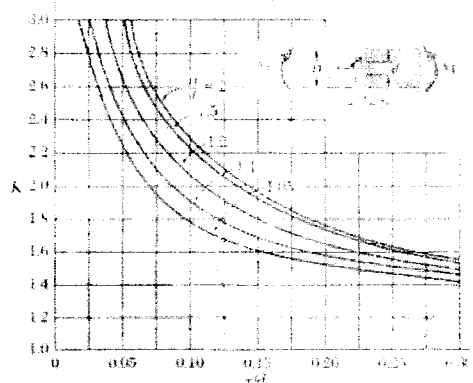
$$\text{Pump efficiency} = \frac{\gamma Q H}{\text{motor power consumption}} = \frac{1000 \times 9.81 \times (0.07) \times (18.80)}{20.4 \times 1000}$$

$$= 0.6328 = 63.28\% \text{ (Answer)}$$

4. Grooves 10 mm deep are to be cut in a steel bar which is 60 mm wide and 9 mm thick as shown. Determine the smallest allowable width of the grooves if the stress in the bar is not to exceed 150 MPa when the bending moment is equal to 180 N·m.



(a) Notched bar dimensions. (b) Cross section.



Stress concentration factors for flat bars with grooves (notches) under pure bending.

Solution: From Figure. (a)

$$d = 60.2 \times 10 = 40 \text{ mm}$$

$$c = \frac{1}{2} d = \frac{1}{2} (40) = 20 \text{ mm}$$

The moment of inertia of the critical cross section about its neutral axis is given by

$$I = \frac{1}{12} b d^3 = \frac{1}{12} \times (9 \times 10^{-3}) \times (40 \times 10^{-3})^3 = 48 \times 10^{-9} \text{ m}^4$$

$$\sigma = \frac{M c}{I} = \frac{180 \times 20 \times 10^{-3}}{48 \times 10^{-9}} = 75 \text{ MPa}$$

$$\text{Using, } \sigma_m = k \frac{M c}{I}$$

$$\Rightarrow 150 = k \times 75$$

$$\Rightarrow K = 2$$

$$\text{Also, } \frac{D}{d} = \frac{60}{40} = 1.5$$

From Graph, and for values of $D/d = 1.5$ and $K = 2$, therefore,

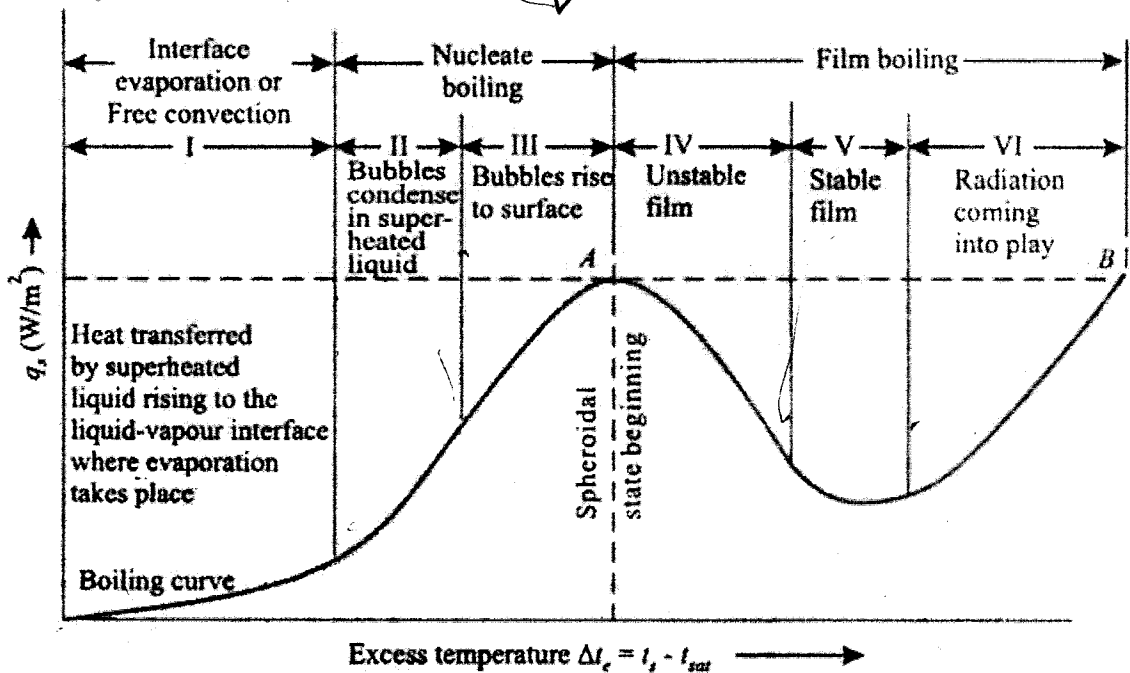
$$\frac{r}{d} = 0.13$$

$$r = 0.13 \times 40 = 5.2 \text{ mm}$$

Thus, the smallest allowable width of the grooves is

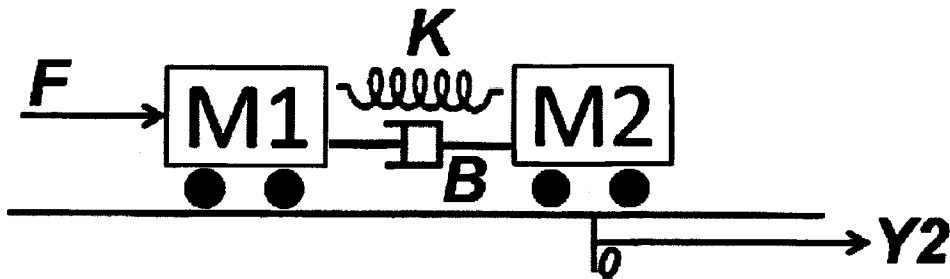
$$2r = 2 \times 5.2 = 10.4 \text{ mm (Answer)}$$

5. Draw the Boiling Curve for water.



The boiling curve for water.

6. Write down the differential equation for the following arrangement.



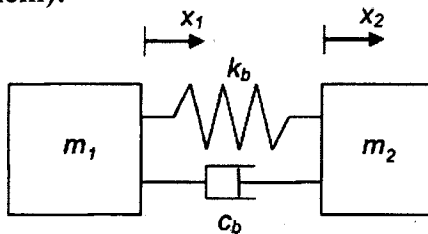
Solution:

$$m_1 \ddot{x}_1 = f(t) + k(x_2 - x_1) + b(\dot{x}_2 - \dot{x}_1)$$

$$m_2 \ddot{x}_2 = k(x_1 - x_2) + b(\dot{x}_1 - \dot{x}_2)$$

where m_1 , m_2 , k and b are Cart mass 1, Cart mass 2, Spring constant and damper constant respectively. All derivatives are in respect to time, t .

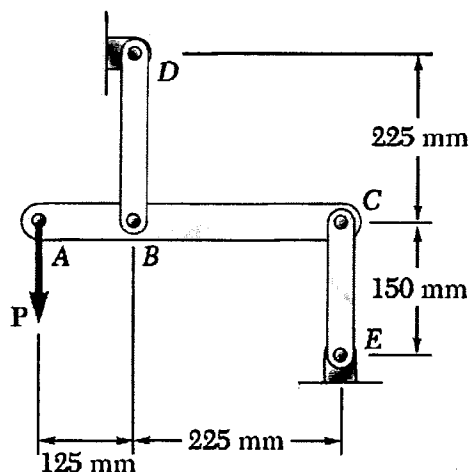
For Practice (Similar Problem):



$$m_1 \ddot{x}_1 + c_b(\dot{x}_1 - \dot{x}_2) + k_b(x_2 - x_1) = 0$$

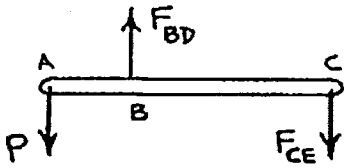
$$m_2 \ddot{x}_2 + c_b(\dot{x}_2 - \dot{x}_1) + k_b(x_1 - x_2) = 0$$

7. Link BD is made of brass ($E=105$ GPa) and has a cross-sectional area of 240 mm^2 . Link CE is made of aluminum ($E=72$ GPa) and has a cross-sectional area of 300 mm^2 . Knowing that they support rigid member ABC and the force $P=50$ kN determine the deflection at B and C.



Solution:

Free body member AC:



$$+\circlearrowleft \Sigma M_C = 0: 0.350P - 0.225F_{BD} = 0$$

$$F_{BD} = 1.55556P$$

$$+\circlearrowleft \Sigma M_B = 0: 0.125P - 0.225F_{CE} = 0$$

$$F_{CE} = 0.55556P$$

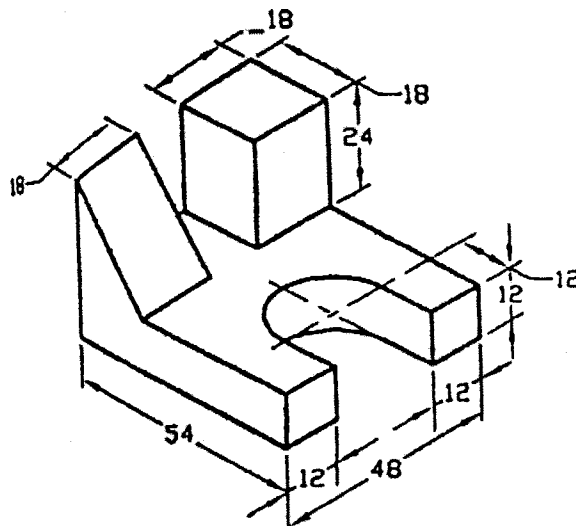
$$\delta_B = \delta_{BD} = \frac{F_{BD} L_{BD}}{E_{BD} A_{BD}} = \frac{(1.55556P)(0.225)}{(105 \times 10^9)(240 \times 10^{-6})} = 13.8889 \times 10^{-9} P$$

$$\delta_C = \delta_{CE} = \frac{F_{CE} L_{CE}}{E_{CE} A_{CE}} = \frac{(0.55556P)(0.150)}{(72 \times 10^9)(300 \times 10^{-6})} = 3.8581 \times 10^{-9} P$$

$$\therefore \delta_B = 0.7 \text{ mm (Answer)}$$

$$\text{And } \delta_C = 0.2 \text{ mm (Answer)}$$

8/ Draw the orthographic projection in third angle view.



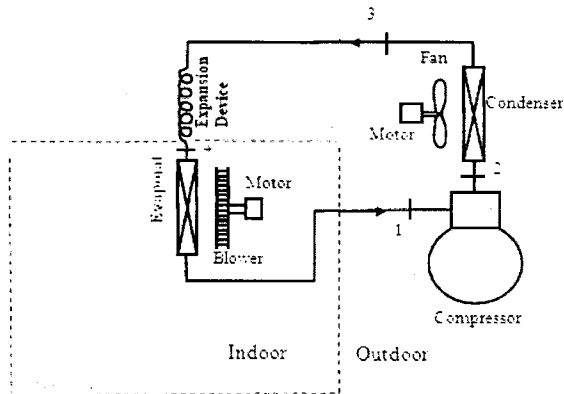
Power Grid Company of Bangladesh (PGCB)**Post: Assistant Engineer(Mechanical)****Date:17.12.2020****Exam Hall: BUET****[Marks Distribution: Departmental-40 Non Departmental-60]****Non departmental-60**

1. Frequency of electric current in Bangladesh-**50Hz**
2. Which is not a base load power plant – **solar**
3. Asian development Bank (ADB) established in–**1966**
4. What is the current membership of ADB?- **68**
5. Height of statue of unity- **182m**
6. More than 50% of electricity is produced from – **natural gas**
7. Indigenous coal is used at – a) **Barapukuria**
8. Parent company of Google- **Alphabet Inc.**
9. Public sector meets what percentage of demand- **55%**
10. 1st election was held in Bangladesh on –**7 march, 1973**
11. Black water related with which country- **USA**
12. Highest electricity consumption sector – **Industry**
13. Which is not nonrenewable source-
14. Bangladesh Tea Board situated in – **Chattogram**
15. BEPZA started its journey from- **15th April, 1981**
16. Which country provides maximum food supply to the world- **USA**
17. Unit of electrical power and energy- **watt and Joule/ KW and KW-hr**
18. Agricultural machinery most imported from which country-**China**
19. What is the full form of Interpol?- **International criminal police organization.**
20. What is the full form of CNN?- **Cable News Network**
21. Which company introduced first laser printer – **IBM**
22. Which is the popular mail service used now a days- **Gmail**
23. In which area most jute produced – **Faridpur**
24. What kind of organization is power cell- **promoting and reforming power sector.**
25. Which spelling is correct- **centrifuge**
26. First sea port after liberation- **Port of Payra**
27. What is the ratio of side of a square to its perimeter?-**1/4**
28. If length of a rectangle is increased by 10% and width decreased by 10% then what will be the change in area? **Area decreased by 1%.**
29. Power cell acts as a government- **Agency**

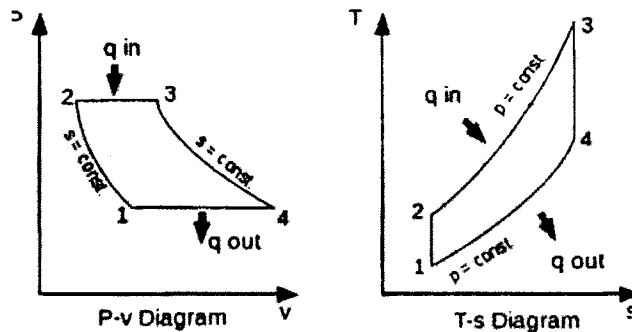
30. On increasing the price of T.V. sets by 30%, their sale decreases by 20% What is the effect on the revenue receipts of the shop? - **4% increase**
31. Find the compound interest on 1000tk at the rate of 20% per year when interest is compound in 6months. -**1095tk**
32. In a certain room, all except 18 of the people are over 50 years of age. If 15 of the people in the room are under 50 years of age, how many people are in the room?
33. A man rows to a place 48 km distant and come back in 14 hours. He finds that he can row 4 km with the stream in the same time as 3 km against the stream. The rate of the stream is: **1km/hr**
34. A positive number when decreased by 4 is equal to 21 times the reciprocal of the number. The number is? a) 3 b) 5 c) 7 d) 9 **Answer: c**
35. From the pack of cards the king of spade is taken out. A card is then drawn, would be a king of hearts find the probability that the card drawn would be a king of hearts_.
1/51
36. If the square root of x is greater than x, then x could be- a) 0 b) $\frac{1}{2}$ c) 2 **Answer: $\frac{1}{2}$**
37. A 30% solution of barium chloride is mixed with 10 grams of water to form a 20% solution. How many grams of the original solution did we start with? - **20grams**
38. LIGHT: BLIND::___? **Speech: Dumb**
39. সংবিধানের অভিভাবক কে? - **Supreme Court**
40. হাড় ও দাঁত গঠনে উপযোগী কোনটি? - ক্যালসিয়াম ও ফসফরাস।
41. ঘোড়াশাল সার কারখানায় উৎপাদিত সার? **ইউরিয়া**
42. প্রধানমন্ত্রী হবার ন্যূনতম বয়স? - **২৫ বছর।**
43. আয়তনে এশিয়ার বৃহত্তম দেশ কোনটি? - **চীন**
44. যে জমিতে ফসল জন্মায় না- **উষর**
45. উহা কোন রীতির শব্দ? - **সাধু**
46. কোনটি অঘোষ অল্পপ্রাণ? - **চ**
47. নীর শব্দের সমার্থক শব্দ কোনটি? **বারি**
48. কাজী নজরুল ইসলাম তার লেখা “সম্বিতা” কাব্যটি কাকে উৎসর্গ করেছিলেন? **রবীন্দ্রনাথকে।**

Departmental

1. Draw block diagram of vapor compression refrigeration system (with main four equipment). How they split into indoor and outdoor part of the split AC.

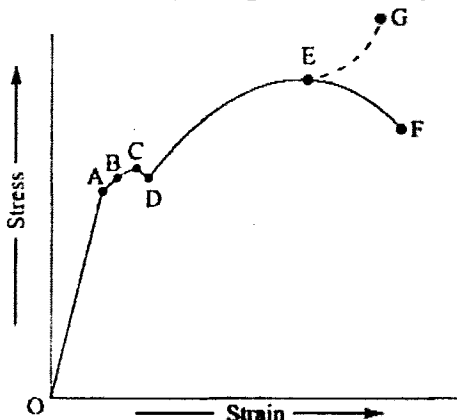


2. Draw P-V and T-S diagram of Joule-Brayton cycle and name the processes.



- 1-2 isentropic compression
- 2-3 constant pressure heat addition
- 3-4 isentropic expansion
- 4-1 constant pressure heat rejection

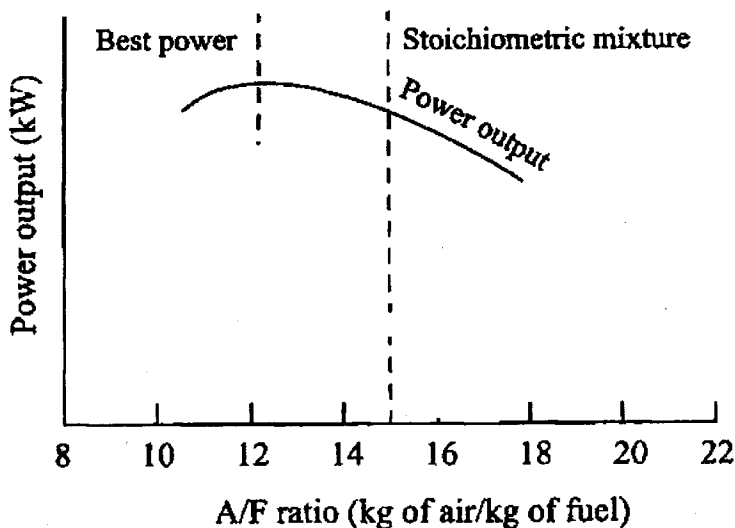
3. Draw stress-strain curve for mild steel and show the following points-Proportional limit, higher yield point, lower yield point, ultimate strength, breaking strength.



- A- Proportional limit
- B- Elastic limit
- C- Upper yield point
- D- lower yield point
- E- Ultimate stress/strength
- F- Breaking stress/strength
- G- Actual Rupture Strength

4. Draw the graph of air fuel ratio vs load/speed of SI engine.

এই প্রশ্নের সঠিক সম্ভাব্য সমাধান।



5. A centrifugal pump has 300mm diameter pipe with $100\text{m}^3/\text{h}$ flow rate. Length of the pipe is 60m and suction head is 1.4m and delivery head is 14.4m. Motor-pump efficiency is 90% and friction factor is 0.06. Calculate power input of the motor.

Solution: Given, $Q=100\text{m}^3/\text{h}=0.0278\text{m}^3/\text{s}$, $D=300\text{mm}$, $L=60\text{m}$, efficiency=90%, $f=0.06$, $P=?$

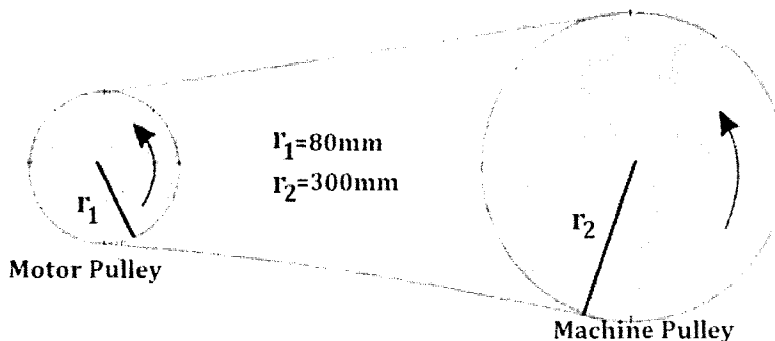
$$Q = AV \text{ or, } V = \frac{Q}{A} = \frac{0.0278}{\frac{\pi}{4} \cdot 0.3^2} = 0.393\text{m/s}$$

$$\text{We get, } H = H_s + H_d + H_f + \frac{v^2}{2g} = 1.4 + 14.4 + \frac{fLV^2}{2gD} + \frac{v^2}{2g}$$

$$= 15.8 + \frac{0.06 \times 60 \times 0.393^2}{2 \times 9.81 \times 0.3} + \frac{0.393^2}{2 \times 9.81} = 15.9\text{m}$$

$$\text{Power required, } P = \frac{\gamma Q H}{\eta} = \frac{1000 \times 9.81 \times 0.0278 \times 15.9}{0.9} = 4818\text{W} = 4.82\text{KW (Answer)}$$

6. Two different size Pulleys (a motor pulley and a machine pulley) are connected through a flat belt. Tension at tight side and slack side are 500N and 350N respectively. The machine shaft has a speed of 1450rpm. Determine the torque required and power transmitted through the machine shaft.



$$Q, \quad k \frac{\Delta T}{x} A$$

Solution:**Given,** $T_1 = 500\text{N}; T_2 = 350\text{N}; r_2 = 300\text{mm} = 0.3\text{m}; N = 1450\text{rpm}.$ Torque = $(T_1 - T_2) r_2 = (500 - 350) \times 0.3 = 45\text{Nm}$ (Answer)Power = $(T_1 - T_2) \frac{2\pi r_2 N}{60} = (500 - 350) \frac{\pi \times 2 \times 0.3 \times 1450}{60} = 6833\text{W}$ (Answer)

7. The inside temperature of a furnace is 1000°C and outside temperature is 200°C . Thickness of the furnace is 100mm and thermal conductivity is 20W/mk . Area 2m^2 . Find heat flow rate.

Solution: Given, $T_1 = 1000^\circ\text{C}, T_2 = 200^\circ\text{C}, x = 100\text{mm}, A = 2\text{m}^2, k = 20\text{W/mk}$

$$Q = kA \frac{\Delta T}{x} = 20 \times 2 \times \frac{(1000 - 200)}{0.1} = 32000\text{J/s} = 32\text{KJ/s}$$
 (Answer)

8. A thin wall cylindrical vessel has diameter of 300mm and its circumferential strength is 180MPa and longitudinal strength 75MPa . Calculate minimum thickness of the vessel if maximum internal pressure is 3MPa .

Solution: Given, $D = 300\text{mm}, \sigma_c = 150\text{MPa}, \sigma_l = 75\text{MPa}, P = 3\text{MPa}, t_{\min} = ?$

$$\sigma_c = \frac{PD}{2t} \text{ or, } t = \frac{PD}{2\sigma_c} = \frac{3 \times 10^6 \times 0.3}{2 \times 180 \times 10^6} = 2.5 \times 10^{-3}\text{m}$$

$$\sigma_l = \frac{PD}{4t} \text{ or, } t = \frac{PD}{4\sigma_l} = \frac{3 \times 10^6 \times 0.3}{4 \times 75 \times 10^6} = 3 \times 10^{-3}\text{m}$$

Minimum thickness, $t_{\min} = 3 \times 10^{-3}\text{m} = 3\text{mm}$ (Answer)

Bangladesh Council of Scientific and Industrial Research (BCSIR)

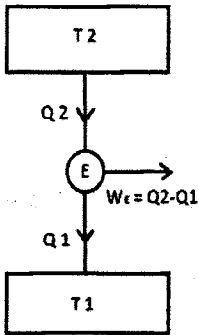
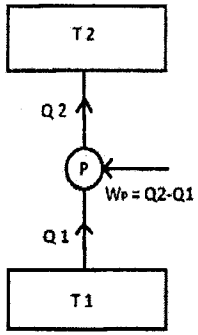
Post: Engineer (Mechanical)

Exam Venue: BCSIR High School

Date: 23.01.2021

[There were Only Departmental 15 questions]

1. Differentiate between heat engine and heat pump.

Heat Engine	Heat Pump
1. A heat engine is a device that absorbs heat (Q_2) and uses it to do useful work (W_E) on the surroundings when operating in a cycle.	1. A heat pump is device that extracts heat from one place and transfers it to another by using mechanical energy. Examples: air conditioner.
2. It is work producing device.	2. It is work consuming device.
3. 	3. 
4. The network done by the engine is given by $W_E = Q_2 - Q_1$	4. The network done by the heat pump is given by $W_P = Q_2 - Q_1$
5. The COP of heat engine is $COP_E = \frac{Q_2 - Q_1}{Q_2}$	5. The COP of heat pump is $COP_{hp} = \frac{Q_2}{W_R} = \frac{Q_2}{Q_2 - Q_1}$

2. Differentiate between Jig and Fixture.

Jig	Fixture
1. Jig is a work holding device that holds supports and locates the workpiece and guides the cutting tool for a specific operation.	1. Fixture is a work holding device that holds, supports and locates the workpiece for a specific operation but does not guide the cutting tool.
2. The main purpose of jigs is to provide repeatability, accuracy and interchangeability in the manufacturing of products.	2. The primary purpose is to create a secure mounting point for a work-piece, allowing for support during operation and increased accuracy, precision, reliability and interchangeability in manufacturing of products.
3. Jig guides the workpiece in machining process.	3. Fixture holds the workpiece securely.

4. Jigs are used in unidimensional machining i.e drilling, reaming, counterboring, tapping etc.	4. Fixtures are used in multidimensional machining i.e milling, planning, slotting, turning, grinding and shaping tools etc. it is also used for assembling and inspection jobs.
5. During machining, Jigs can hold in position simply by hand pressure. They may be clamped to machine table for heavier work.	5. Fixtures are always rigidly fixed on machine table.

3. Discuss about TCs and RTDs.

Thermocouple (TCs)

When two conductors made from dissimilar metals are connected forming two common junctions and the two junctions are exposed to two different temperatures, a net thermal emf (electromagnetic force) is produced, the actual value is dependent on the materials used and the temperature difference between hot and cold junctions. The thermoelectric emf generated, in fact, is due to the combination of two effects: Peltier effect and Thomson effect. As temperature goes up, this output emf of the thermocouple rises (though not necessarily linearly)

Resistance Temperature Devices (RTD)

Resistive temperature devices works on the principle that the electrical resistance of material changes with its temperature. It is well known that resistance of metallic conductors increases with temperature. Resistance thermometers employing metallic conductors for temperature measurement are called Resistance Temperature Detector (RTD). As their name indicates, RTDs rely on resistance change in a metal, with the resistance rising more or less linearly with temperature. The variation of resistance of metals with temperature is normally modeled in the form:

$$R_1 = R_0 [1 + a (t - t_0)]$$

where R_0 and R_1 are resistance at temperature t and t_0 , respectively.

4. What is knocking in IC engine? What its effect?

knocking: The rapid auto-ignition of a portion of a fuel causes a pressure wave of high intensity to be set up in the cylinder of an I.C. engine. This pressure wave of high intensity propagates rapidly through the gas gives a violet blow to the walls of the cylinder, to the combustion chamber and to the piston. A loud pulsating noise known as knocking is produced which gives violent vibration to the engine. The knock in S.I. engines is characterized by sudden auto-ignition of the charge farthest away from the spark plug while in case of C.I. engines it is characterized by the sudden auto-ignition of the mixture at the very beginning of the combustion process. Knocking in CI engine always occurs before TDC means initial phase of combustion and detonation in SI engine always occurs after TDC means last phase of combustion.

Effect of Knocking:

As a result of knocking, the thermal boundary layer at the combustion chamber walls can be destroyed. This causes increased heat transfer which might then lead to certain surfaces causing pre-ignition. So, knocking combustion causes major engine damage, and also reduces the efficiency.

5. What is the significance of dimensionless number? Discuss the significance of Reynolds number and Nusselt Number.

Answer: Significance of dimensionless number: Dimensionless numbers have high importance in the field of fluid mechanics as they determine behavior of fluid flow in many aspects. These dimensionless numbers are of key importance in parametric analysis of engineering problems. They are also extremely useful in understanding the similarity among problems belonging to the same broad class.

Reynolds Number: It is defined as the ratio of the inertia force to the viscous force. i.e.,
 $Re = \text{Inertia Force} / \text{Viscous Force} = \rho V D / \mu = V D / \nu$

Significance:

- Reynolds number signifies the relative predominance of the inertia to the viscous forces occurring in the flow systems.
- Higher the Reynolds number the greater will be the relative contribution of inertia effect. Smaller the value of Re , the greater will be the relative magnitude of the viscous stresses.
- Reynolds number is taken as an important criterion of kinematic and dynamic similarities in forced convection heat transfer.
- It indicates that the flow is laminar or turbulent. For pipe flow if $Re < 2000$, the flow is laminar, if $Re > 4000$, the flow is turbulent. If $2000 < Re < 4000$ it is transition. For flat plate in case of laminar flow $Re < 50,000$ and in case of turbulent, Re is between 50,000 to 100,000.

Nusselt Number (Nu): It is the ratio of heat flow rate by convection process under a unit temperature gradient to the heat flow rate by conduction process under a unit temperature gradient through a stationary thickness of L meters. i.e.

$$Nu = hL/K$$

Significance:

- The Nusselt number represents the enhancement of heat transfer through a fluid layer as a result of convection relative to conduction across the same fluid layer.
- The larger the Nusselt number, the more effective the convection.
- A Nusselt number of $Nu = 1$ for a fluid layer represents heat transfer across the layer by pure conduction.

6. Define: Welding, Soldering, Brazing, TIG and MIG.

Welding: Welding is a means of joining metals by concentrating heat or pressure or both at the joint to cause coalescence of the adjoining areas. A good weld is as strong as the parent metal. Welding is done in a number of ways. Welding is done in manual, semi-automatic, or automatic operations, depending largely upon the quantity and variety of work.

Soldering: Soldering or soft soldering is the process of joining metals by means of alloys that melt between 177–371°C (350–700°F). The alloys are generally lead and tin alloys. The

metals mostly joined by soldering are iron, copper, nickel, lead, tin, zinc, and many of their alloys. Aluminum can be soldered by special means. The strength of a soldered joint depends on surface alloying and upon mechanical bonding, such as crimping, between the joined parts. For soldering, a flux is generally necessary to rid the surface of oxides, to promote wetting and obtain intimate contact between the solder and base metal.

Brazing: Brazing is the name given a group of welding operations in which a nonferrous filler metal melts at a temperature below that of the metal joined, but is heated above 427°C (800°F). The molten filler metal flows by capillarity between the heated but unmelted adjacent or overlapping joint members or is melted in place between those members.

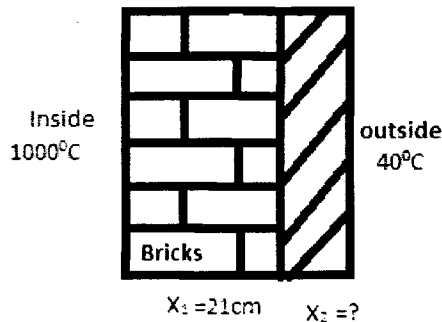
TIG: Tig (tungsten inert-gas-shielded arc welding) utilizes a tungsten alloy electrode that does not waste away in an inert-gas atmosphere. Filler metal is put in by a separate rod or wire as needed. Helium and argon alone, together, or mixed with other gas form the shield. The process requires care and skill, but makes clean and reliable welds. Its use is especially important in aerospace and other critical applications.

MIG: Mig (metal inert-gas-shielded arc welding), is done with a wire fed through the welding head to act as the electrode and supply filler metal as depicted. Inert gases are used for critical jobs, but cheaper carbon dioxide has become quite popular for a large variety of production operations.

7. Differentiate between NC and CNC.

NC	CNC
1. NC stands for Numerical Control	1. CNC stands for Computer Numerical Control.
2. NC is a machine which is controlled by the set of instructions in the form of numbers, letters and symbols. In this case, the set of instruction is referred to as program.	2. CNC is a machine which is used to control the motions of the workpiece and tool with the help of prepared program in computer. The program is written in alphanumeric data.
3. In NC machine the programs are fed into the punch cards.	3. In CNC machines the programs are fed directly into the computer by a small keyboard similar to our traditional keyboard.
4. Modification in the program is difficult.	4. Modification in the program is very easy.
5. The programs in the NC machine cannot be stored.	5. In CNC machines, the programs can be stored in the computer and can be used again and again.
6. The accuracy is less as compared with the CNC.	6. It has high accuracy.
7. Maintenance cost is less.	7. The maintenance cost is high.

8. A 21cm thick brick wall having thermal conductivity $k=1.04 \text{ W/mK}$ and is insulated with a material having $k=0.07 \text{ W/mK}$. Inside & outside temperature 1000°C and 40°C respectively. Heat loss is 960 W/m^2 . Find thickness of insulation. [Similar]



Solution: We get, $Q/A = \frac{\Delta T}{\frac{x_1}{k_1} + \frac{x_2}{k_2}}$ or, $960 = \frac{(1000-40)}{\frac{0.21}{1.04} + \frac{x_2}{0.07}} \therefore x_2 = 0.0558\text{m} = 5.58\text{cm}$ (Answer)

9. Draw the block diagram of Rankine cycle with T-S diagram.

Answer:

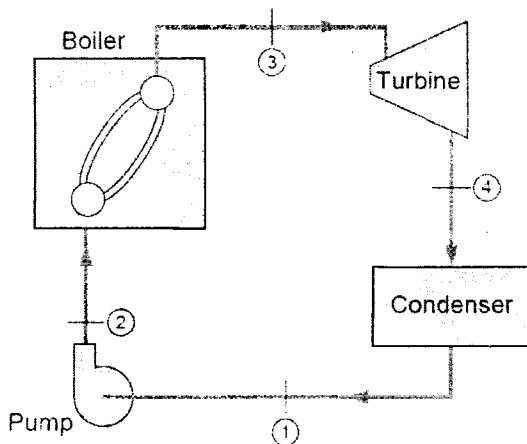


Figure: Simple steam power plant that operates on the Rankine cycle

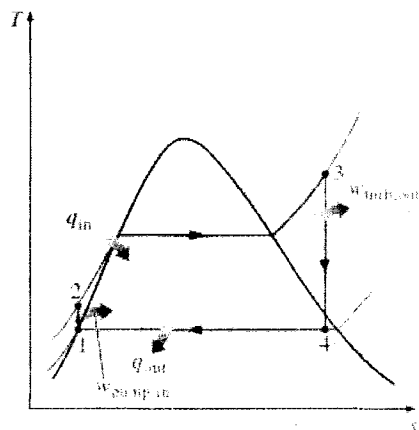
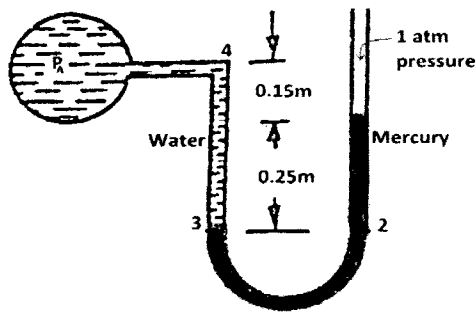


Fig.: T-S diagram of Rankine cycle

10. Find the head lost due to friction in a pipe of diameter 300mm and length 50m, through which water is flowing at a velocity of 3m/s. Take $f = 0.01024$ [Similar]

Solution: Here, $d = 300\text{mm} = 0.30\text{m}$; $L = 50\text{m}$; $V = 3\text{m/s}$; $f = 0.01024$

We get, $h_f = \frac{fLV^2}{2gd} = \frac{0.01024 \times 50 \times 3^2}{2 \times 9.81 \times 0.30} = 0.7828\text{m}$ (Answer)

11. Calculate the pressure P_A . [Similar]

Solution: At the datum line 3-2, we get,

$$P_A + (\rho gh)_{\text{water}} = P_{\text{atmosphere}} + (\rho gh)_{\text{mercury}}$$

$$\text{or, } P_A + (1000 \times 9.8 \times 0.4)_{\text{water}} = 101325 + (13.6 \times 1000 \times 9.8 \times 0.25)_{\text{mercury}}$$

$$\text{or, } P_A = 134645 - 3920 = 130725 \text{ Pa}$$

$$\therefore P_A = 130.725 \text{ KPa (abs.) (Answer)}$$

12. A hydroelectric power station is supplied with water under a head of 20m. The overall efficiency is 80% and power output 27.468MW. Find the flow rate. [Similar]

Solution:

Given data:

$$\text{Flow rate, } Q = 175 \text{ m}^3/\text{s}$$

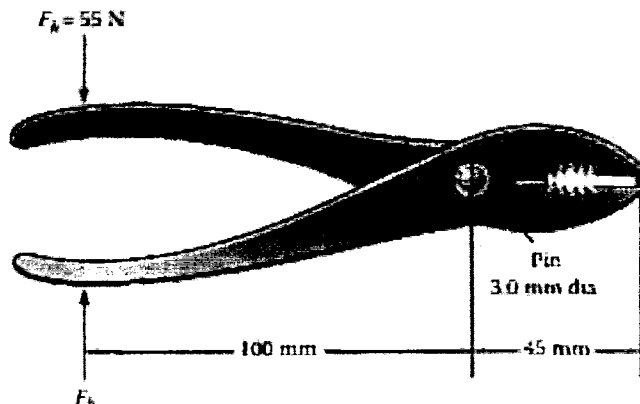
$$\text{Head of water, } H = 20 \text{ m}$$

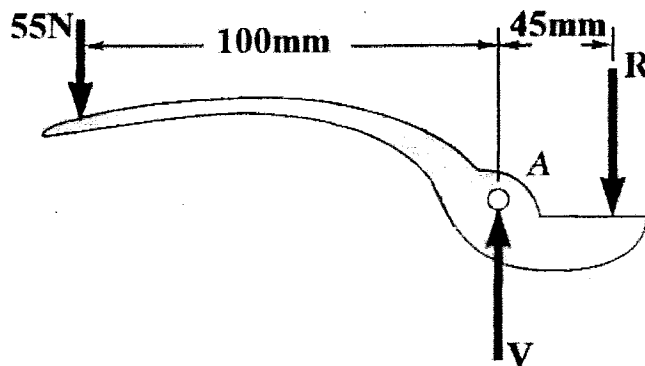
$$\text{Overall efficiency, } \eta_0 = 80\%$$

$$\text{Now overall efficiency, } \eta_0 = \frac{P}{Q\gamma H}$$

$$\Rightarrow Q = \frac{27.468 \times 10^6}{0.8 \times 9.81 \times 1000 \times 20}$$

$$\Rightarrow Q = Q = 175 \text{ m}^3/\text{s (Answer)}$$

13. A pair of pliers grips the bolt as shown. Determine the shear force acting on the pin at A. [Similar]

Solution:

$$\sum M_C = 0$$

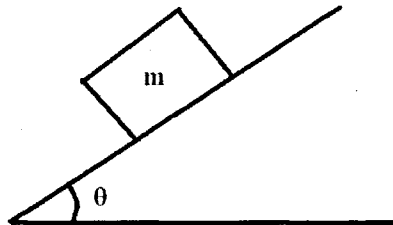
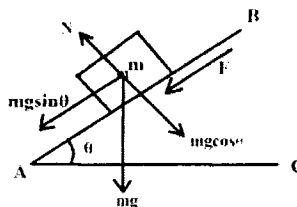
$$\Rightarrow 55 \times (100 + 45) - V \times 45 = 0$$

$$\therefore V = 177.22 \text{ N}$$

$$\text{Area of pin, } A_{\text{pin}} = \frac{\pi}{4} \times d^2 = \frac{\pi}{4} \times 3^2 = 7.07 \text{ mm}^2$$

$$\text{Shear stress in the pin } = \tau_{\text{pin}} = \frac{V}{A} = \frac{177.22}{7.07} = 25 \text{ N/mm}^2 = 25 \text{ MPa (Answer)}$$

14. Derive the expression for starting the block moving up, where m is the mass of the block, θ is the inclination angle and μ is the friction factor. [Similar]

**Solution:**

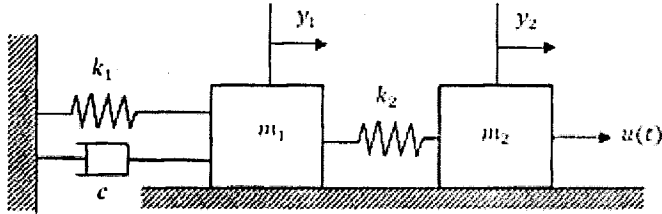
Minimum force required to move up the body, $F_{\text{min}} = mg \sin \theta + F$

[Friction force, F is in downward direction because the block is moving upward]

$$= mg \sin \theta + \mu N$$

$$= mg \sin \theta + \mu mg \cos \theta = mg (\sin \theta + \mu \cos \theta) \text{ (Answer)}$$

15. Write down the differential equation for the spring mass system. [Similar]



Solution: The differential equation is-

$$m_1 \ddot{y}_1 = k_2(y_2 - y_1) - k_1 y_1 - c \dot{y}_1$$

Coal Power Generation Company Bangladesh Limited (CPGCBL)

Post: Assistant Engineer(Mechanical)

Date: 07.01.2021

Exam Hall: BUET

[Marks Distribution: Departmental- (5×8=) 40 & Non Departmental- 60]

Non departmental-60

1. In which year the constitution of Bangladesh was written? – 1972
2. Where is saarc disaster management centre located? – New Delhi, India
3. $2^{30} + 2^{30} + 2^{30} + 2^{30} = ?$
(a) 8^{120} (b) 8^{30} (c) 2^{32} (d) 2^{30}
Answer: (c)
4. NATO was formed in the year_? April 4, 1949
5. Who was the Relief and Rehabilitation minister of Mujibnagar government?
– AHM Qamaruzzaman
6. The first government was formed in Bangladesh_? 10 April 1971
7. Who was the commander in chief during the liberation war?- General M. A. G. Osmani
8. সমীর শব্দের অর্থ কি? (a) সমুদ্র (b) কুয়াশা (c) উত্তরীয় (d) বাতাস
Answer: (d)
9. 'অনল প্রবাহ' রচনা করেন কে?- (a) ইসমাইল হোসেন সিরাজী (b) কাজী নজরুল ইসলাম (c) ফররুখ আহমদ (d) সৈয়দ আলী আহসান
Answer: (a)
10. নিচের কোনটি সঠিক বানান? বিঘ্নদ্রুভ
11. Civil Society এর পরিভাষা নিচের কোনটি? (a) সভ্য সমাজ (b) সুশীল সমাজ (c) বেসামরিক সমাজ (d) কোনটিই নয়

Answer: (b)

12. 'গৌফ খেজুরে' বাগধারাটির অর্থ কি? (a) নিতান্ত অলস (b) আরাম প্রিয় (c) উদাসীন (d) পরমুখাপেক্ষী

Answer: (a)

13. কোন চরণটি সঠিক? (a) ধন ধান্যে পুষ্পে ভরা (b) ধন্য ধান্যে পুষ্পে ভরা (c) ধণ্যে ধান্যে পুষ্পে ভরা (d) ধণ্যে ধান্য পুষ্পে ভরা

Answer: (a)

14. বীরশ্রেষ্ঠ খেতাব প্রাপ্ত মুক্তিযোদ্ধা- ৭জন

15. What is the percentage of generation using coal among total generation? 8.07%
(According to BPDB website)

16. In which place electricity is generated by using imported coal? – Patuakhali

17. The installed capacity of Matarbari coal power plant?- 1200MW

18. Which is incorrect for CPGCBL? (a) Sole power plant using coal (b) Japan invested (c) Public company(GOB) (d) thinking LNG plant for future

19. Per capita energy generation in Bangladesh? – 512KW-hr

20. Maximum Power generation difference between winter and summer?- 3000MW-5500MW

21. Which acid is present in tomato?

(a) Sulphuric acid (b) HCl (c) Both A & B (d) Citric acid

22. Hemoglobin related to— iron

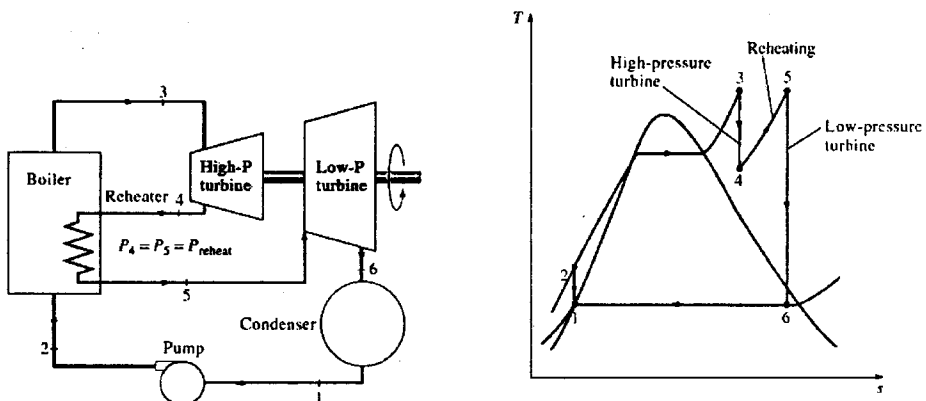
23. Correct spelling— accommodation

24. The Tk-10 bank account means: to take a collateral-free loan of Tk 50,000 from a bank for the first time in life by the poor people.

[বাকি প্রশ্নগুলো সংগ্রহ করা সম্ভব হয়নি]

Departmental-40

1. Draw the block diagram and T-S diagram of reheat Rankine cycle.



2. A thin-walled double-pipe counter-flow heat exchanger is to be used to cool oil ($C_p = 2200 \text{ J/kg} \cdot ^\circ\text{C}$) from 150°C to 40°C at a rate of 2 kg/s by water ($C_p = 4180$)

J/kg · °C) that enters at 22°C at a rate of 1.5 kg/s. find the oil water exit temperature and the LMTD. [Similar]

Solution:

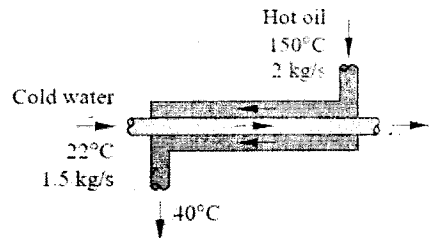
The rate of heat transfer from the water to the

$$\text{oil is } \dot{Q} = [\dot{m}C_p(T_{in} - T_{in})]_{oil} \\ = 2 \times 2.2 \times (150 - 40) = 484 \text{ KW}$$

The outlet temperature of the water is

$$\text{determined from, } \dot{Q} = [\dot{m}C_p(T_{out} - T_{in})]_{water}$$

$$\Rightarrow T_{out} = T_{in} + \frac{\dot{Q}}{\dot{m}C_p} = 22 + \frac{484}{1.5 \times 4.18} \\ = 99.2 \text{ } ^\circ\text{C (Answer)}$$



LMTD:

$$\Delta T_1 = T_{h,in} - T_{c,out} = 150 - 99.2 = 50.8 \text{ } ^\circ\text{C}$$

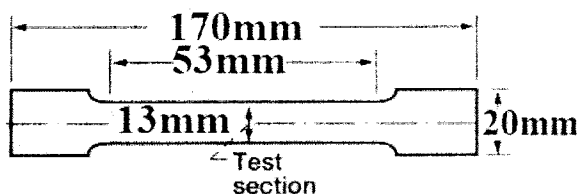
$$\Delta T_2 = T_{h,out} - T_{c,in} = 40 - 22 = 18 \text{ } ^\circ\text{C}$$

$$\therefore \text{ LMTD} = \frac{\Delta T_1 - \Delta T_2}{\ln \frac{\Delta T_1}{\Delta T_2}} = \frac{50.8 - 18}{\ln \frac{50.8}{18}} = 31.6 \text{ } ^\circ\text{C}$$

(Answer)

In exam the flow rate was given in l/s (Volumetric flow rate) unit and specific gravity was given, in this case \dot{m} = specific gravity \times volumetric flow rate

- 3. A circular bar fails at 60KN gauge length 53mm and elongation length 58mm. Calculate the percentage of elongation and tensile strength of the bar. [Similar]**

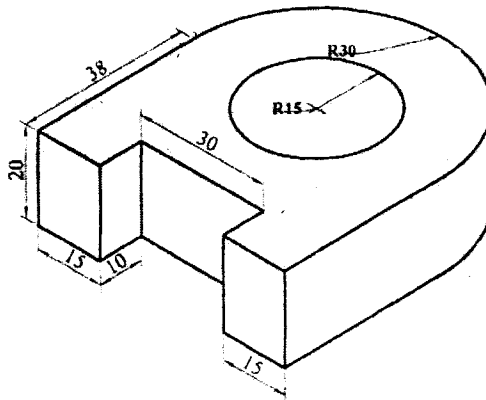


Solution: Given that, diameter = 13mm, Gauge length, $L_g = 53$ mm, Braking load = 60 KN, Final length after elongation, $L_e = 58$ mm

$$\text{We get, Percentage of elongation} = \frac{L_e - L_g}{L_g} \times 100\% = \frac{58 - 53}{53} \times 100\% = 9.43\% \text{ (Answer)}$$

$$\text{Again, Tensile strength} = \frac{\text{Braking load}}{\text{Cross sectional area in the gauge section, } A_g} \\ = \frac{60 \times 1000}{\frac{\pi}{4} \times 13^2} = 452.04 \text{ MPa (Answer)}$$

4. The following machine part is made of brass, density $\rho = 8.65 \text{ gm/cm}^3$. i) What will be the final weight? ii) If it is made from $(70 \times 65 \times 22)$ mm material. What percentage of material will be lost in machining process? [Similar]



Solution:

$$\text{i) Final weight} = 8.65 \times [(3.8 \times 6 \times 2) - (3 \times 1 \times 2) + \frac{1}{2} \times \pi \times 3^2 \times 2 - \pi \times 1.5^2 \times 2] \text{ gm}$$

$$= 8.65 \times [45.6 - 6 + 28.27 - 14.13] = 464.851 \text{ gm (Answer)}$$

$$\text{ii) Weight before machining} = (7.0 \times 6.5 \times 2.2) \times 8.65 = 865.865 \text{ gm}$$

$$\therefore \text{Percentage of material will be lost in machining process} = \frac{865.865 - 464.851}{865.865} \times 100\%$$

$$= 46.31\% \text{ (Answer)}$$

5. Air kinematic viscosity of $1.5 \times 10^{-5} \text{ m}^2/\text{s}$ is transported through a pipe of 1cm diameter and 500m length with a flow rate of $70 \text{ cm}^3/\text{sec}$. Find head loss and pressure drop. [Similar]

Solution: Here, $\nu = 1.5 \times 10^{-5} \text{ m}^2/\text{s}$, $D = 1 \text{ cm} = 0.01 \text{ m}$, $L = 500 \text{ m}$, $Q = 70 \text{ cm}^3/\text{sec}$

$$V = \frac{Q}{A} = \frac{70}{\frac{\pi \times 1^2}{4}} = 89.13 \text{ cm/s} = 0.8913 \text{ m/s}$$

$$\text{We get, } Re = \frac{VD}{\nu} = \frac{0.8913 \times 0.01}{1.5 \times 10^{-5}} = 594.2$$

$\therefore Re < 594.2$, so, the flow is laminar.

$$\therefore f = \frac{64}{Re} = 0.108$$

$$h_f = \frac{fV^2}{2gD} = \frac{0.108 \times 500 \times (0.8913)^2}{2 \times 9.81 \times 0.01} = 218.65 \text{ m of air. (Answer)}$$

$$\text{And, pressure drop} = P_1 - P_2 = \rho gh_f = 1.21 \times 9.81 \times 218.65 = 2595.4 \text{ Pa}$$

$$= 2.595 \text{ KPa (Answer)}$$

Bangladesh Industrial and Technical Assistance Centre (BITAC)

Post: Junior Engineer (Mechanical)

Time-3:00PM to 4:00PM

Date: 08.01.2021

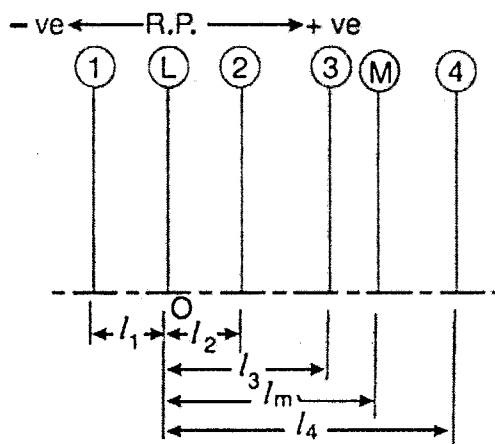
Exam Hall: BUET

Departmental

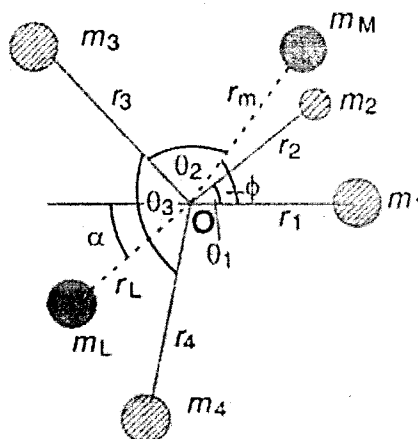
1. At which condition masses attached to a shaft on different planes can be completely balanced?

Answer: In order to have a complete balance of the several revolving masses in different planes, the following two conditions must be satisfied:

1. The forces in the reference plane must balance, i.e. the resultant force must be zero.
2. The couples about the reference plane must balance, i.e. the resultant couple must be zero.



(a) Position of Planes of masses



(b) Angular position of the masses

2. A closed vessel contains 2 kg of carbon dioxide at temperature 20°C and pressure 0.7 bar. Heat is supplied to the vessel till the gas acquires a pressure of 1.4 bar and temperature of 313°C . Calculate the work done on or by the gas and change in internal energy. Take specific heat of the gas at constant volume as 0.657 kJ/kg K .

Solution:

Work done: Since there is no volume change, work done on or by the gas is zero.

(i.e. $W_{1-2} = p \times dV = 0$) (**Answer**)

Change in internal energy:

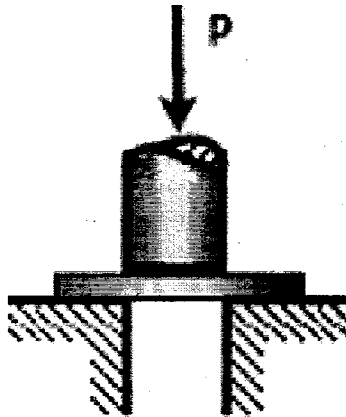
Change in internal energy = Heat added – workdone

Heat added during constant volume process is given by:

$$Q = m C_v (T_2 - T_1) = 2 \times 0.657 \times (586 - 293) = 385 \text{ KJ}$$

$$\therefore \text{Change in internal energy} = 385 - 0 = 385 \text{ KJ (Answer)}$$

3. As in Fig., a hole is to be punched out of a plate having a shearing strength of 40 ksi. The compressive stress in the punch is limited to 50 ksi. Compute the maximum thickness of plate in which a hole 2.5 inches in diameter can be punched.



Solution:

Based on puncher strength

$$P = \sigma A$$

$$= 50 \times \frac{1}{4} \times \pi \times 2.5^2$$

$$= 78.125\pi \text{ kips}$$

This is the equivalent shear force of the plate.

$$\therefore V = P$$

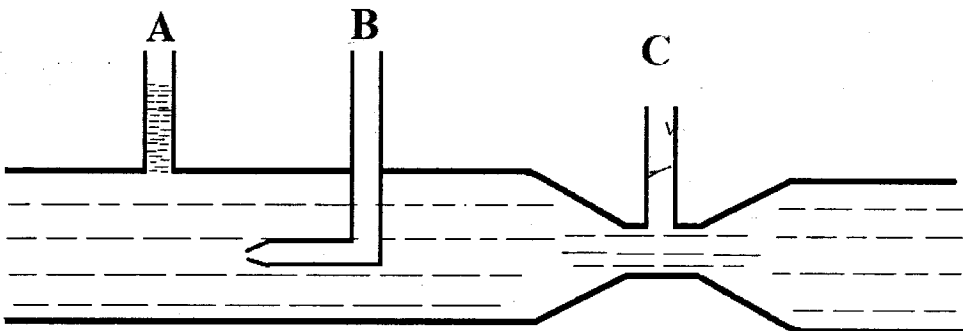
Based on shear strength of plate,

$$V = \tau A$$

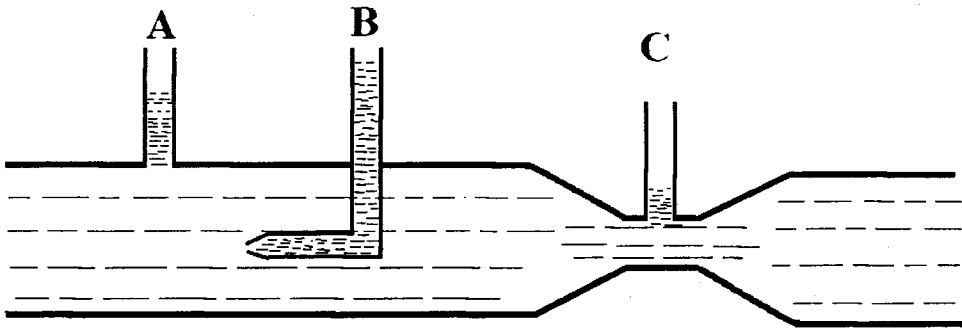
$$\Rightarrow 78.125\pi = 40 \times \pi \times 2.5t$$

$$\Rightarrow t = 0.751 \text{ inch (Answer)}$$

4. Show the water level of tube B & C compare to tube A? Also mention the cause.



Solution:



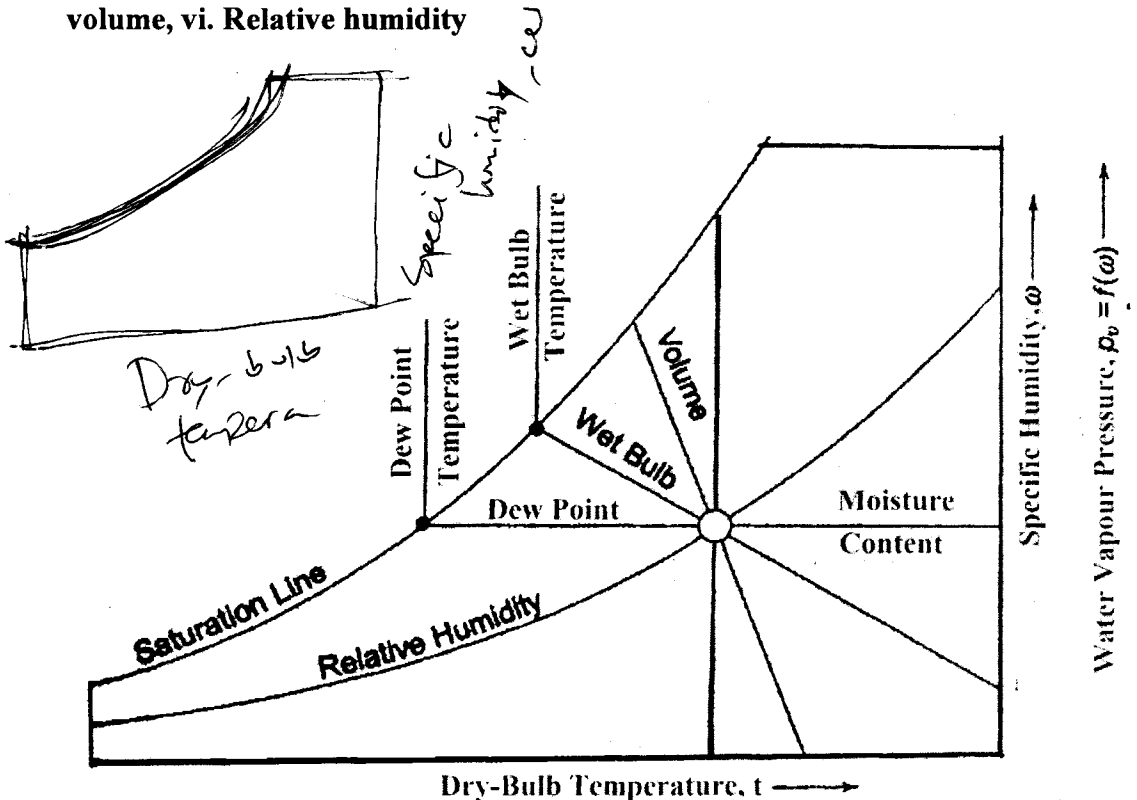
Cause:

Tube B: In the inlet of tube B due to the stagnation point, velocity will be zero, so the pressure will be high and consequently the water height will be high in this tube.

Tube C: Here, area is less than the point A and so, the velocity will be high and pressure will be less, consequently the water height will be lower in this tube.

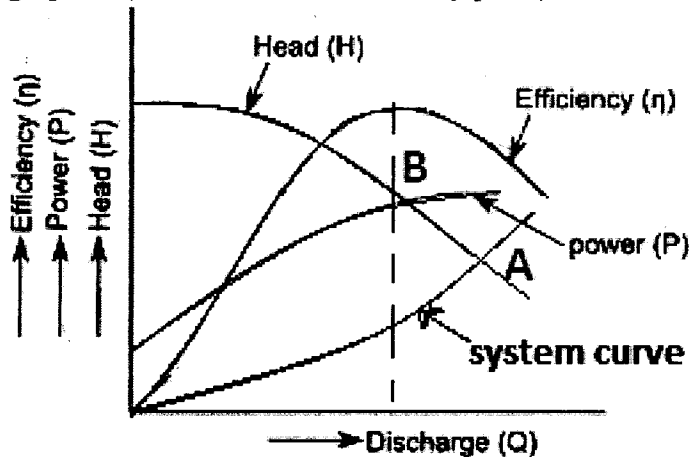
5. In a psychrometric chart show different lines intersect at a point.

- i. Dry bulb, ii. Wet bulb, iii. Specific enthalpy, iv. Moisture content v. Specific volume, vi. Relative humidity

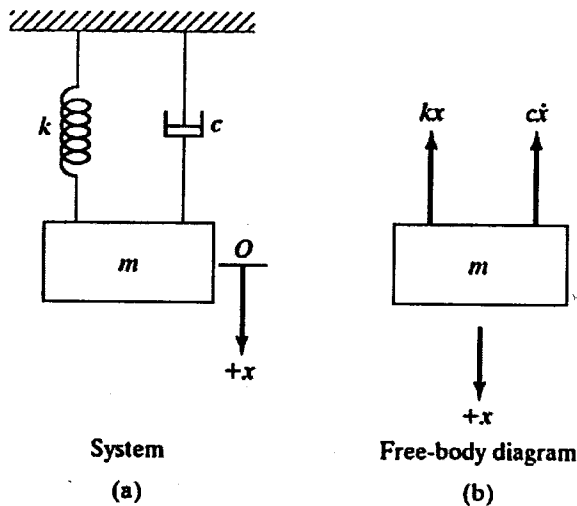


6. Draw the typical performance curve of centrifugal pump showing the duty point and operating point.

Answer: Here, Point A is the operating point (where system curve and head curve meets; system curve is a function of elevation or static head including major and minor losses). Point B is the **design** point (consider at best efficiency point).



7. Write down the equation of free damping and the relation between S and C.



Solution:

Equation of motion:

$$m\ddot{x} + c\dot{x} + kx = 0 \quad (\text{Answer})$$

Solution in the form:

$$X(t) = C e^{st}$$

Where C and s are undetermined constants

The characteristic equation is

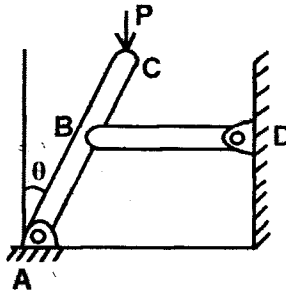
$$ms^2 + cs + k = 0$$

The roots and solutions are

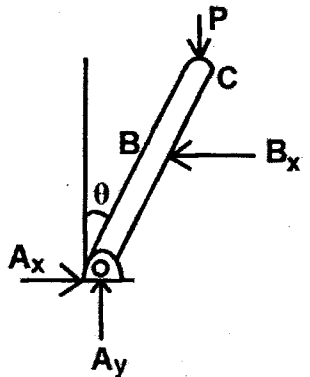
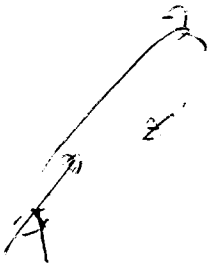
$$S_{1,2} = \frac{-C \pm \sqrt{C^2 - 4mk}}{2m}$$

$$= -\frac{c}{2m} \pm \sqrt{\left(\frac{c}{2m}\right)^2 - \frac{k}{m}} \quad (\text{Answer})$$

8. $AB = BC$. BD horizontal. Express reaction at A using P and θ .



Solution:



Rest = 0

$$\begin{aligned}\uparrow \sum F_y &= 0 \\ \Rightarrow A_y - P &= 0 \\ \Rightarrow A_y &= P\end{aligned}$$

$$\begin{aligned}\rightarrow \sum F_x &= 0 \\ \Rightarrow A_x - B_x &= 0 \\ \Rightarrow A_x &= B_x\end{aligned}$$

Moment at A,

$$\circlearrowleft \sum M_A = 0$$

$$\Rightarrow -B_x \times AB \cos \theta + P \times AC \sin \theta = 0$$

$$\Rightarrow B_x = \frac{P \times AC \sin \theta}{AB \cos \theta} = \frac{P \times (AB + BC) \sin \theta}{AB \cos \theta} = \frac{P \times 2 \times AB \times \sin \theta}{AB \cos \theta} = 2P \tan \theta \quad [\because AB = AC]$$

$$\therefore A_x = B_x = 2P \tan \theta$$

$$\therefore \text{Reaction at A, } A = \sqrt{A_y^2 + A_x^2} = \sqrt{P^2 + (2P \tan \theta)^2} = P \sqrt{1 + 4 \tan^2 \theta} \quad (\text{Answer})$$

Non-departmental

1. ঘোড়াশাল সার কারখানায় উৎপাদিত সারের নাম কি?

ক. টিএসপি খ. ইউরিয়া গ. পটাশ ঘ. অ্যামোনিয়া সালফেট

উত্তরঃ খ

2. A train, 150m long, passes a pole in 15 seconds and another train of the same length travelling in the opposite direction in 12 seconds. The speed of the second train is

a) 45 km/hr

b) 48 km/hr

c) 52 km/hr

d) 54 km/hr

Answer: d) 54 km/hr

Explanation:

speed of the first train = $150/15 = 10$ m/s; time taken by trains to cross each other = 12 sec. and

Relative speed of two trains = $(150+150)/12 = 25$ m/s

∴ Speed of the second train = $(25-10) \times 185 = 54 \text{ km/hr.}$

3. Length of Padma bridge: **6.15km**

4. ১৯৭১ সালে সেক্টর ২ এর কমান্ডার কে ছিলেন? - মেজর খালেদ মোশাররফ

5. বাংলাদেশ এই পর্যন্ত কত গুলো টেস্ট জিতেছে? - ১৪ টি

6. বীরশ্রেষ্ঠ মোস্তফা কামালের বাড়িকোথায়? - বরিশালের দৌলতখান থানার পশ্চিম হাজীপাড়া গ্রামে

7. “আলালের ঘরের দুলাল” কার লেখা? - প্যারীচাঁদ মিত্র

8. ২০১৯-২০ অর্থবছরে বাংলাদেশে জিডিপি প্রবৃদ্ধি ছিল- ৫ দশমিক ২৪ শতাংশ

9. There are 3 green, 4 orange and 5 white color bulbs in a bag. If a bulb is picked at random, what is probability of having either a green or a white bulb? - $\frac{3+5}{12} = \frac{8}{12} = \frac{2}{3}$

10. On reducing the entry fee by 35% in a park, the number of people coming to the park increased by 40%, then the percent increase or decrease in the income from the entry fee is- **9% decrease**

11. In a class, there are 15 boys and 10 girls. Three students are selected at random. The probability that 1 girl and 2 boys are selected, is:

a) 21/46 b) 1/5 c) 3/25 d) 1/50

Answer: **a) 21/46**

12. Asian Development Bank (ADB) member countries- **68**

13. কোনটি শুদ্ধ বানান?

ক) নুনতম খ) নুন্যতম গ) নূনতম ঘ) নূন্যতম

14. “ক” তে কোন কোন বর্ণ আছে? ক+ষ

[বাকি প্রশ্নগুলো সংগ্রহ করা সম্ভব হয়নি]

RPCL-NORINCO Intl. Power Limited (RNPL)

Date: 22.01.2021

Total Marks: 100, Time: 2 hrs

Venue: Nawab Habibullah Model School & College Uttara

[কিছু প্রশ্ন সংগ্রহ করা সম্ভব হয়নি। নৈব্যক্তিক প্রশ্নের অপশন ছিল না তেমন। উত্তর লিখতে হবে। বাকি প্রশ্নের মান ১-৪ নম্বরের মত।]

1. Indulge synonym: cater (to), gratify, humor

2. Writer of the book “wings of fire” - Dr. A. P. J. Abdul Kalam

3. পেঁপে পাকলে হলুদ দেখায় কেন? - পেঁপে যখন পেকে যায় তখন ক্লোরোফিল জীব রাসায়নিক পরিবর্তনের মাধ্যমে জ্যাক্সোফিলে রূপান্তরিত হয়। এ কারণে পেঁপে পাকলে হলুদ হয়।

8. ভানুসিংহ কার ছদ্ম নাম? - রবীন্দ্রনাথ ঠাকুর

৫. বিদ্রোহী কবিতা কত সালে প্রকাশিত হয়? - ১৯২২ সালে

6. 9. National children's day of Bangladesh- 17th March.

7. 10. Power generation target of Bangladesh Government by 2041? - 60,000MW

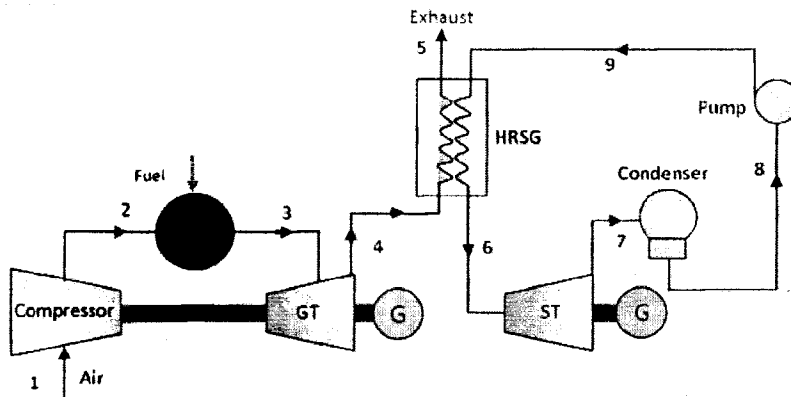
8. If the price of a book is first decreased by 25% and then increased by 20%, then the net charges in the price will be : 10% decrease
9. Area of a square 144 sq.ft. Find the width of a rectangle whose length is 9ft and area half of the square?- 8ft
10. A person invested 45000 taka by each share 60 taka and invested 30000 taka by each share 30 taka. What is the average price of share?
11. If six people all shake hands with each other, how many handshakes were made in total?- 15
12. Half the people on a bus get off at each stop after the first, and no one gets on after the first stop. If only one person gets off at stop number 7, how many people got on at the first stop? – 64
13. A computer cannot "boot" if it does not have the _____.
 A) Compiler
 B) Loader
 C) Operating system
 D) Assembler

Answer: C) Operating system

14. BD cricket team won the first ODI Series Against which country?- Zimbabwe
15. রোহিঙ্গা ইস্যুতে পশ্চিম আফ্রিকার কোন দেশ আন্তর্জাতিক আদালতে মামলা করে?- গাম্বিয়া।
16. East London is situated at_. Answer: South Africa
17. Antonym of "Solidarity"- disagreement, antagonism, discord, divorce, separation.
18. 'জলৌকা' শব্দের সন্ধি বিচ্ছেদ কোনটি?- জল+ওকা
19. When Karnaphuli Hydroelectric Power Plant was started its electricity generation?- 1962
20. কতজন নারী বীর প্রতীক খেতাবে ভূষিত হয়েছেন?- ২ জন
২১. বিশ্বের সবচেয়ে দীর্ঘতম নদী কোনটি?- নীলনদ
22. Wall : Mason:: _? - Chef : Cook
23. বঙ্গবন্ধুর ঐতিহাসিক এই মার্চের ভাষণ সংবিধানের কোন তফসিলে অন্তর্ভুক্ত করা হয়েছে?- পঞ্চম তফসিল
24. বাংলাদেশের নদী গবেষণা ইনস্টিটিউট কোথায় অবস্থিত ? - ফরিদপুর
25. The construction of Lalbag fort was started in 1678 AD by- Mughal Subahdar Muhammad Azam Shah

12. Draw the schematic of combined cycle power plant.

Answer:



13. Calculate the refrigeration tonnage for 3000kg ice from 0°C to 30°C.

Solution: Here, $m = 3000\text{kg}$; $\Delta\theta = (30^\circ - 0^\circ) = 30\text{K}$

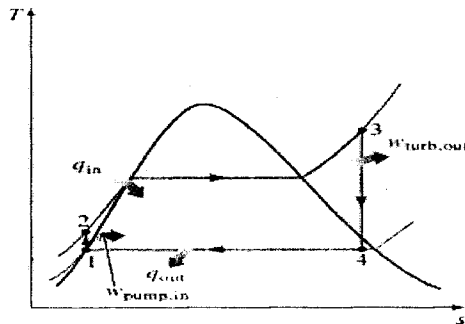
$$\begin{aligned}\text{We get, amount of heat} &= \frac{m l_f}{24 \times 60} + \frac{m s \Delta\theta}{24 \times 60} = \frac{3000 \times 333.5}{24 \times 60} + \frac{3000 \times 4.2 \times 30}{24 \times 60} \\ &= 957.29 \text{Kj/min} = \frac{957.29}{210} \text{ ton} = 4.55 \text{ ton}\end{aligned}$$

\therefore Refrigeration tonnage = 4.55 (Ans.)

14. Draw T-S diagram of Rankine cycle mentioning all processes and corresponding equipment.

Solution:

The T-S Diagram of Rankine cycle is shown below:



1-2 Isentropic compression in a pump

2-3 Constant pressure heat addition in a boiler

3-4 Isentropic expansion in a turbine

4-1 Constant pressure heat rejection in a condenser

15. Write the two basic differences between the diesel engine and petrol engine.

1. In petrol engine fuel and air both are compressed with a spark while in diesel engine only air is compressed, and fuel is injected in compressed air through the injector.
2. Petrol engine works on Otto cycle and diesel engine works on diesel cycle.

16. What is deaeration? Why it is done and where?

Answer: Deaeration is the removal of dissolved or entrained gases from water to be used as boiler feed or for other processes. The gases of concern to steam plant operators are usually oxygen and carbon dioxide which are present in water due to natural cases.

Why it is done:

Oxygen and carbon dioxide present in untreated water cause corrosion of the usual boiler and steam plant materials. The rate of the corrosive action is proportional to the amount of the gas present in the feedwater and is accelerated by high temperature.

There are five major problems directly associated with water quality that will effect boiler performance. These are Scale formation, Corrosion, Fouling, Foaming and Embrillement.

17. What is knocking? What is the problem from it?

Detonation/ knocking: The rapid auto-ignition of a portion of a fuel causes a pressure wave of high intensity to be set up in the cylinder of an I.C. engine. This pressure wave of high

intensity propagates rapidly through the gas gives a violent blow to the walls of the cylinder, to the combustion chamber and to the piston. A loud pulsating noise known as knocking is produced which gives violent vibration to the engine. The term detonation is used to indicate precede of gas vibration and term knock is used to include all phenomenon that arise from auto-ignition. The knock in S.I. engines is characterized by sudden auto-ignition of the charge farthest away from the spark plug while in case of C.I. engines it is characterized by the sudden auto-ignition of the mixture at the very beginning of the combustion process.

18. What is heat treatment? Why it is done?

Heat treatment: The process of heat treatment is carried out first by heating the metal and then cooling it in the caustic soda solution, brine, water, oil or air.

The purpose of heat treatment is to soften the metal, to change the grain size, to modify the structure of the material and to relieve the stresses set up in the material after hot or cold working.

19. Define “ton of refrigeration”.

Answer: Ton of refrigeration/TR: A ton of refrigeration is defined as the amount of refrigeration effect produced by the uniform melting of one ton (1000kg) of ice from and at 0 degree centigrade in 24 hours.

$$1\text{TR} = 210 \text{ kJ/min} = 3.5 \text{ kW}$$

20. What are the components of Coal fired power plant?

Answer: Main parts of the plant are

1. Coal conveyor 2. Stoker 3. Pulverizer 4. Boiler 5. Coal ash 6. Air preheater
7. Electrostatic precipitator 8. Smoke stack 9. Turbine 10. Condenser 11. Transformers 12. Cooling towers 13. Generator 14. High - voltage power lines

12. A shaft is transmitted 50 hp, speed of the shaft is 400 rpm. What is the torque?

Solution: Given that, $P = 50 \text{ hp} = 37.285 \text{ KW}$ $N = 400 \text{ rpm}$

$$\omega = \frac{2\pi N}{60} = \frac{2\pi \times 400}{60} = 41.88 \text{ rad/sec}$$

We get,

$$P = T \times \omega$$

$$\Rightarrow T = \frac{P}{\omega} = \frac{37.285}{41.88}$$

$$\therefore T = 0.89 \text{ KN.m (Ans.)}$$

21. Full form of: ASHRAE- American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASTM- American Society for Testing and Materials

EEC- Electronic engine control

ECM- Electronic Control module

22. Write while the petrol engine or diesel engine is used in the following vehicles:

Name of the Vehicles

Petrol or Diesel Engine

Buses, Trucks

Answer: Diesel Engine

(Heavy Duty, High speed)

Scooters, Motorcycles, Cars

Petrol Engine

(Light Duty, High speed)

Aero plane, Aircraft
(High speed)
Ships, Marine vehicles

Petrol Engine
Diesel Engine

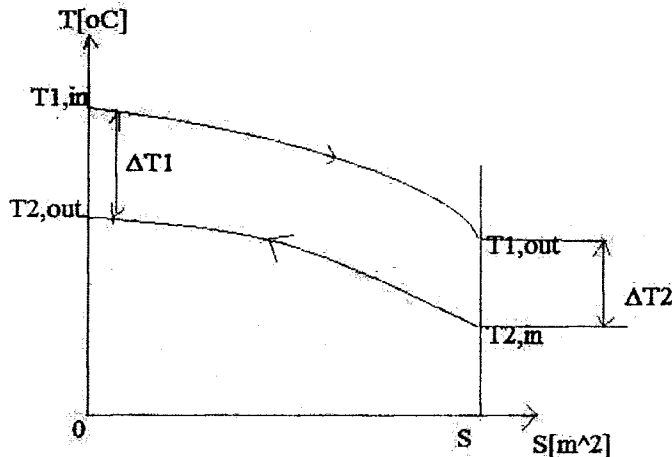
23. Carnot engine receives 500 KJ of heat from a high temperature source (625°C) and rejects heat to a low temperature sink (30°C). What will be the efficiency of Carnot heat engine?

Solution: Given that, $T_1 = 625^{\circ}\text{C} = 625 + 273 = 898\text{ K}$ & $T_2 = 30^{\circ}\text{C} = 30 + 273 = 303\text{ K}$.

We get, $\eta = \frac{T_1 - T_2}{T_1} = \frac{898 - 303}{898} = 0.6626 = 66.26\%$ (Answer)

24. Water is heated from 35°C to 75°C by oil in a counter flow double pipe heat exchanger. The oil enters the heat exchanger at 111°C and leave at 75°C . Calculate LMTD in this situation.

Solution:



Here, $T_{\text{cin}} = 35^{\circ}\text{C}$ and $T_{\text{cout}} = 75^{\circ}\text{C}$, $T_{\text{hin}} = 111^{\circ}\text{C}$ and $T_{\text{hout}} = 75^{\circ}\text{C}$.

$\Delta T_1 = T_{\text{hin}} - T_{\text{cout}} = 111 - 75 = 36$ and $\Delta T_2 = T_{\text{hout}} - T_{\text{cin}} = 75 - 35 = 40$

$$\begin{aligned} \therefore \text{LMTD} &= \frac{\Delta T_2 - \Delta T_1}{\ln \frac{\Delta T_2}{\Delta T_1}} \\ &= \frac{40 - 36}{\ln \frac{40}{36}} \end{aligned}$$

$$\therefore \text{LMTD} = 37.97 \approx 38^{\circ}\text{C} \text{ or } 38\text{ K (Ans.)}$$

25. Two gears A and B mesh with each other. The speed of gear A is 795rpm. Number of teeth of the two gears A and B are respectively 50 and 20. Find speed of gear B.

Solution:

Given, $N_A = 795\text{ rpm}$; $T_A = 50$; $T_B = 20$; $N_B = ?$

We get, $\frac{N_B}{N_A} = \frac{T_A}{T_B}$

$$\therefore N_B = \frac{50}{20} \times 795 = 1987.5 \text{ rpm (Ans.)}$$

26. Write the name of 5 systems of an engine.

Answer:

1. Air intake systems
2. Exhaust systems
3. Cooling systems
4. Lubrication systems
5. Fuel systems

27. What are the successes of present government in power sector in last 10 years?

The performance of Bangladesh's power sector in the last ten years has been impressive due to the progressive efforts of policymakers, support from developing partners, and effective project implementation by public and private developers. Present installed capacity of power generation is 21,239MW. Including Captive Power & Off Grid Renewable Energy Total Installed Capacity (21,239+2,800+382) =24,421 MW. Bangladesh government has increased its number of power plant at 141 from the only 27 power plants in the year 2009. It has been increased 12494 ckt km transmission line from the 8000ckt km transmission line in the year 2009. Per capita electricity generation is increased at 512KW-hr in the 2019-2020 fiscal years. Almost 100% of the population is under the privileges of electricity all over the country.

The government has taken steps for generating mix energy including renewable energy, nuclear energy as well as coal, gas, HFO based power plant. The government has a target for the generation 10% of its total energy from the renewable power source with in 2021. There are several large power plants are under construction like- Rooppur nuclear power plant with two units each of 1200MW, Rampal coal power plant, Matarbari coal power plant each of 1200MW and the Payra, the largest coal based power plant of Bangladesh already is in service. The distribution system loss decreased into single digit by the planning of Bangladesh Government.

28. Write 6 points on covid-19 prevention.

- ✓ Wear mask when go at outside.
- ✓ Avoid the mass gathering
- ✓ staying home when sick;
- ✓ covering mouth and nose with flexed elbow or tissue when coughing or sneezing. Dispose of used tissue immediately;
- ✓ washing hands often with soap and water; and
- ✓ cleaning frequently touched surfaces and objects.

18. জাতীয় জীবনে একুশে বইমেলার গুরুত্ব।

বাংলা একাডেমির অমর একুশে গ্রন্থমেলা একুশের বইমেলা নামেই পরিচিত। এই মেলা বাঙালির প্রাণের মেলা লেখকের মেলা, প্রকাশকের মেলা, পাঠকের মেলা। এই মেলাকে কেন্দ্র করেই প্রকাশিত হয় শতকরা প্রায় ৯০ ভাগ সৃজনশীল বই। এই বইমেলার

সঙ্গে জড়িয়ে আছে ১৯৫২ সালের ২১শে ফেব্রুয়ারি ভাষা শহিদদের স্মৃতি এর সঙ্গে মিশে আছে বঙালির চেতনা, মাতৃভাষার জন্য আবেগ-ভালোবাসা। বঙালির সাহস, ভালোবাসা এবং প্রতিবাদের প্রতীক এই বইমেলা। একুশের ইতিহাস তাই আজও শাসন জুগিয়ে চলেছে লেখক, পাঠক, প্রকাশকদের। আর এই বইমেলা একুশের চেতনা থেকে উৎসারিত। একুশের আত্মত্যাগের কারণে আজ আমাদের মাতৃভাষা বাংলা রাষ্ট্রভাষা।

বইমেলা শুধু বইমেলা নয়, ফেব্রুয়ারি মাসের প্রথম দিন থেকে শেষ দিন পর্যন্ত বাংলা একাডেমির মূল মঞ্চে আয়োজন করা হয় ভাষা, সাহিত্য এবং সংস্কৃতিভিত্তিক আলোচনা সভা এবং অনুষ্ঠান। তাতে বিদেশি লেখকরাও অংশ নেন।

Bangladesh Hi-Tech Park Authority
Post: Assistant Engineer(Mechanical)

Date:06.02.2020

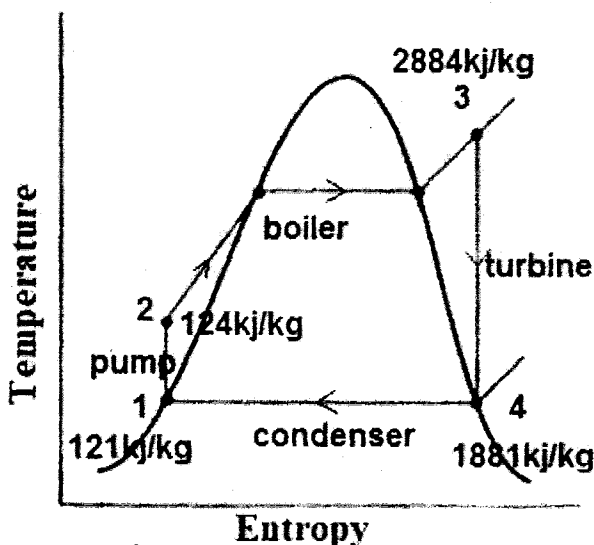
Exam Hall: MIST

[Marks Distribution: Departmental-40 Non Departmental-45]

Departmental-40

1. In a steam power plant, inlet and exit enthalpy of a turbine is 2884kJ/kg and 1881kJ/kg respectively. Inlet and exit enthalpy of pump is 121kJ/kg and 124kJ/kg respectively. Draw the corresponding T-S diagram and net work done per kg and specific steam consumption in kg/kw.hr.

Solution:



$$\text{Net work done} = W_t - W_p = (h_3 - h_4) - (h_2 - h_1)$$

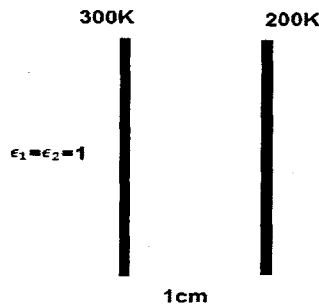
$$= (2884 - 1881) - (124 - 121) = 1000 \text{ kJ/kg}$$

$$\text{Specific steam consumption, ssc} = \frac{3600}{\text{net work done}}$$

$$= \frac{3600}{W_{\text{net}}} = \frac{3600}{1000} = 3.6 \text{ kg/kw. hr} \quad (\text{Answer})$$

2. Two parallel plates 1cm apart and filled up with air. The emissivity of them are same and its equal to one. Thermal conductivity of air is .0293w/m⁰C. Find the heat transfer rate per unit area.

Solution:



Heat transfer by radiation, $\frac{Q}{A} = \frac{\sigma(T_1^4 - T_2^4)}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1} = \frac{5.67 \times 10^{-8}(300^4 - 200^4)}{\frac{1}{1} + \frac{1}{1} - 1}$
 $= 368.55 \text{ W/m}^2$

Heat transfer by conduction, $\frac{Q}{A} = K \frac{\Delta T}{x} = 293 \text{ W/m}^2$

Total heat transfer per unit area = $368.55 + 293 = 661.55 \text{ W/m}^2$ (Answer)

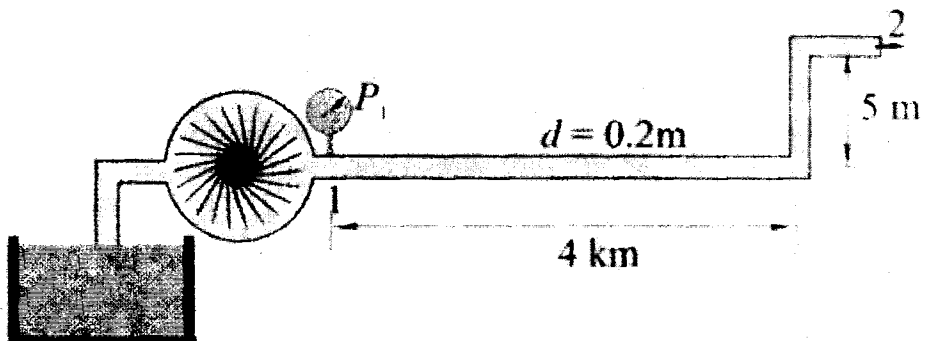
3. A cylindrical vessel having 40mm internal diameter and the thickness of the vessel is 5mm. If the allowable stress is 30MPa. Determine the maximum internal pressure of the vessel.

Solution:

$\sigma_c = \frac{PD}{2t}$ or, $P = \frac{30 \times 10^6 \times 40 \times 10^{-3}}{2 \times 5 \times 10^{-3}} = 7.5 \text{ MPa}$ (Answer)

4. A centrifugal pump is required to pump water to an open water tank situated 4 km away from the location of the pump through a pipe of diameter 0.2 m having Darcy's friction factor of 0.01. The average speed of water in the pipe is 2 m/s. If it is to maintain a constant head of 5 m in the tank, neglecting other minor losses, what is the absolute discharge pressure at the pump exit?

Solution:



Let, P_1 be the pressure at the exit of pump.

Applying Bernoulli's equation between exit of pump and the tank,

$$\frac{p_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + z_2 + h_f$$

$$\Rightarrow \frac{p_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{p_2}{\rho g} + \frac{v_2^2}{2g} + z_2 + \frac{f l v^2}{2gd}$$

Here, $v_1 = v_2 = v = 2 \text{ m/s}$, $l = 4000 \text{ m}$, $d = 0.2 \text{ m}$, $f = 0.01$, $P_2 = 1 \times 10^5 \text{ N/m}^2$ and $Z_2 - Z_1 = 5 \text{ m}$

We have,

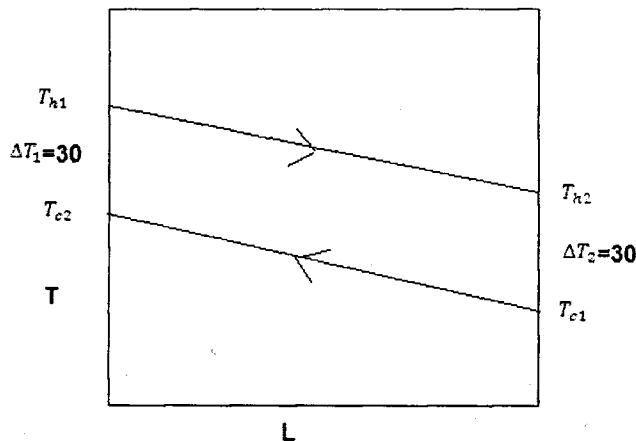
$$\frac{p_1}{1000 \times 9.81} + \frac{2^2}{2 \times 9.81} = \frac{1 \times 10^5}{1000 \times 9.81} + \frac{2^2}{2 \times 9.81} + 5 + \frac{0.01 \times 4000 \times 2^2}{0.2 \times 2 \times 9.81}$$

$$\Rightarrow P_1 = 5.503 \times 10^5 \text{ N/m}^2$$

$\therefore P_1 = 5.503 \text{ bar (Answer)}$

5. In a counter flow heat exchanger hot fluid enters at 60°C and cold fluid leaves at 30°C . Mass-flow rate of hot fluid is 1 kg/s and cold fluid is 2 kg/s . Specific heat for hot and cold fluid are $10 \text{ kJ/kg}^\circ\text{C}$ and $5 \text{ kJ/kg}^\circ\text{C}$ respectively. Determine LMTD.

Solution:



$$[mc(T_{h1} - T_{h2})] = [mc(T_{c2} - T_{c1})]$$

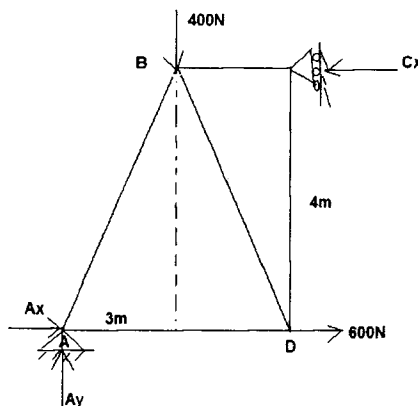
$$\text{or, } 1 \times 10 \times (60 - T_{h2}) = 2 \times 5 \times (30 - T_{c1})$$

$$\therefore (T_{h2} - T_{c1}) = 30^\circ\text{C}$$

$$\Delta T_1 = 60 - 30 = 30 \text{ and } \Delta T_2 = 30$$

Since temperature difference on both side is same so, LMTD = 30°C or, 30K (Answer)

6. Find the forces at point A.



$$\sum M_A = 0 \text{ or, } 400 \times 3 = C_x \times 4 \therefore C_x = 300\text{N}$$

$$\sum F_x = 0 \text{ or, } A_x - C_x + 600 = 0 \text{ or, } A_x = -600 + 300 = -300\text{N} = 300\text{N} \leftarrow$$

$$\sum F_y = 0 \text{ or, } A_y - 400 = 0 \text{ or } A_y = 400\text{N}$$

$$A = \sqrt{A_x^2 + A_y^2} = 500\text{N and } \theta = 53.13^\circ \text{ (Answer)}$$

7. The brake power of an IC engine is 10KW and angular velocity is 400rad/s. Determine the required torque.

Solution: $P = T\omega \therefore T = \frac{P}{\omega} = \frac{10 \times 1000}{400} = 25\text{Nm (Answer)}$

8. Write short note on-a) Reynolds number b) COP

Non departmental

1. Find the mean deviation from the observations 5,8,9,11,12,14,15,15
2. Permutation of "REMAINS", keep vowel in odd positions-
3. What is the official name of aghortala shorojonto mamla- state of Pakistan vs. sheikh mujibur rahman and others.
4. When declared Kazi Nazrul Islam is a national poet-
Couldn't collect others questions

Bangladesh Rural Electrification Board (BREB)

Post: Assistant Engineer (Mechanical)

Time-10.00AM to 11AM

Date:19.02.2021

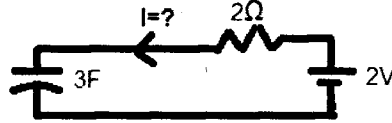
(MCQ Exam)

Marks: 50

Time: 01hour

1. The maximum force required to slide a body of weight W on a rough horizontal plane is
 a. $W \sin \theta$ b. $W \cos \theta$ c. $W \tan \theta$ d. none of these
 প্রশ্নে maximum চাপা দেয়া হয়েছে, এইক্ষেত্রে maximum মান থাকতে পারে কি!
2. What is the per capita energy generation of Bangladesh-**512KW**
3. Which alternator has more number of poles- a) wind b) hydro c) steam d) gas
4. Resistance of an ideal ammeter is – **zero**
5. Who do you give the money _? a. for b. by c. with d. **to**
6. How many power distribution utilities in Bangladesh– **6**
7. Which of the following property is desirable for materials used in tools and machines?
 a. **Elasticity** b. Plasticity c. Ductility d. Malleability
8. Theoretical air fuel ratio of petrol engine – **15:1**
9. Petrol engine works on which cycle- **Otto**

10. Diesel engine compression ratio-**15 to 25**
11. If the clearance volume increases then the compression ratio will – **decrease**
12. In a centrifugal pump, regulatory valve located in which section-
a) suction pipe **b) delivery pipe** c) Casing d) impeller
13. For low discharge and high heads which pump is used- **reciprocating**
14. Velocity ratio of 3rd system of pulley is- **$2^n - 1$**
15. Which one is more ductile- **a. mild steel** b. Aluminum c. copper d. Nickel
16. 2nd law of thermodynamics defines- **entropy**
17. The variation of volume with the variation of pressure is – **compressibility**
18. The entropy may be expressed as a function of
a. pressure b. temperature
c. pressure and temperature d. none
19. Deformation per unit length is – **strain**
20. Unit of strain – **no unit**
21. Joule is a unit of – **a. Work** b. Energy c. Power d. Torque
22. Length of Padma bridge – **6.15km**
23. The feminine of 'drone' – **bee**
24. The mercury does not wet the glass. This is due to the property of the liquid known as **a. Cohesion** b. Adhesion c. Viscosity d. Surface tension
25. Reynolds number is the ratio of inertia force to – **viscous force**
26. Actual power generated in the engine cylinder of an IC engine – **BHP**
27. Which one is not correct?- **$A + A' = 1$**
28. "Candela" is a unit of – **luminous intensity**
29. One kg of carbon produces _ kg of carbon dioxide- a. 3/7 b. 7/3 **c. 11/3** d. 3/11.
30. One ton of refrigeration = **12000BTU/hr**
31. The universal gate is ____ a. AND gate b. OR gate c. Both **d. None**
32. Which is water tube boiler- **Babcock and Wilcox boiler**
33. Bernoulli's equation is applied to
a. Venturimeter b. Orifice meter c. Pitot tube **d. All of these**
34. The brass and bronze are welded by ____ flame.
a. neutral **b. oxidizing** c. carburizing d. all of these
35. The taper on the lathe spindle is
a. 1 in 10 b. 1 in 15 **c. 1 in 20** d. 1 in 30
36. How many economic zone will be by 2030- **100**
37. What is the value of I (amp) in the ckt? **(a) 0amp** (b) 1amp (c) 0.1amp (d) none



38. Which device can restrict broadcast traffic- **router**
39. If an atom loses electron, it is called-**positive ion**
40. Short cut command for cut- **ctrl. +X**
41. Heat is rejected by refrigerator in- **condenser.**
42. অগ্নির সমার্থক নয়- প্রজ্জ্বলিত
43. সঠিক বানান- অনুকূল
44. একটি থলিতে ৪টি লাল, ৫টি সবুজ এবং ৬টি নীল কলম আছে। একটা কলম উঠালে তা সবুজ না হওয়ার সম্ভাবনা?-
২/৩
45. ৭ম পঞ্চবার্ষিকী পরিকল্পনার মেয়াদকাল- ২০১৬-২০২০
46. বাংলাদেশের সংবিধানে কোন অনুচ্ছেদে পল্লী বিদ্যুতায়নের কথা বলা হয়েছে-১৬
47. বাংলাদেশ সরকারের প্রধান আইন কর্মকর্তা- কোনটি নয় (এটর্নি জেনারেল হবে)
48. অনেকের মধ্যে এক- অন্যতম
49. ব্লাক বেঙ্গল কোন প্রাণী- ছাগল
50. ডিজিটাল বাংলাদেশ দিবস- ১২ ডিসেম্বর

Bangladesh Rural Electrification Board (BREB)

Post: Assistant Manager (Mechanical)

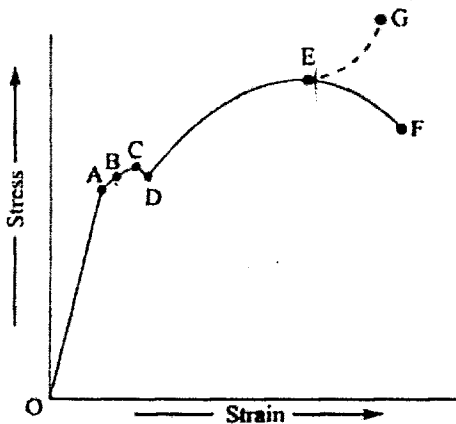
Exam Venue: Training Academy Building, BREB, Nikunjo, Dhaka.

Date: 20.02.2021

Total Marks: 50

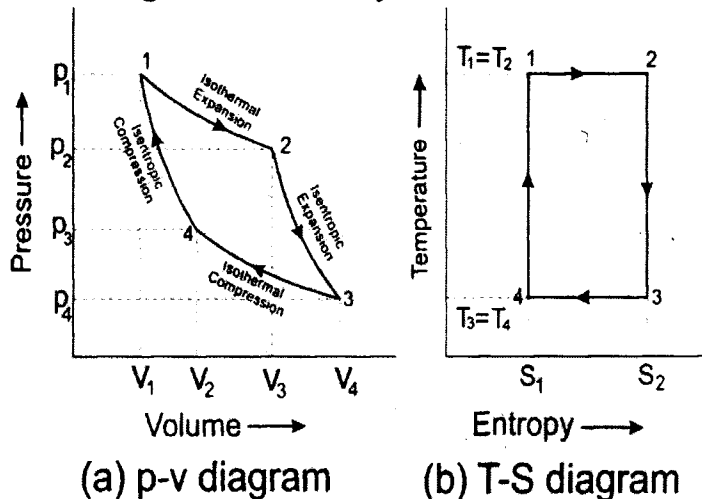
Departmental (5×5=25)

1. Draw the stress-strain curve of mild steel under tensile test.



- A- Proportional limit
- B- Elastic limit
- C- Upper yield point
- D- lower yield point
- E- Ultimate stress/strength
- F- Breaking stress/strength
- G- Actual Rupture Strength

2. Draw the P-V and T-S diagram of Carnot cycle.



(a) p-v diagram

(b) T-S diagram

3. Write down five advantages of supercharging.

- Higher power output
- Greater induction of charge mass
- Better mixing of fuel and air
- Complete and smooth combustion
- Reduced exhaust smoke
- Increased mechanical efficiency

4. Write down five important properties of metals.

i) Strength: It is the ability of a material to resist deformation under the action of tensile, compressive or shear force. The strength of a component is usually based on the maximum load that can be borne before failure is apparent. The most common measure of strength is the yield strength.

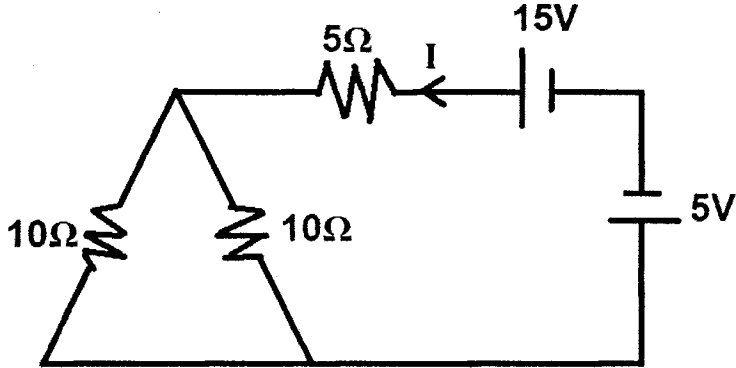
ii) Hardness: It is the ability of a material to offer resistance to penetration or indentation. It is also the ability to resist wear, abrasion, scratch or cutting.

iii) Brittleness: It is that property by virtue of which a material breaks easily under action of shock loads without appreciable amount. It indicates the lack of ductility. For example glass, ceramics and cast iron are brittle materials.

iv) Ductility: It is a measure of the amount of deformation of a material can withstand before breaking. It is also the ability of a material by which it can be drawn into wires.

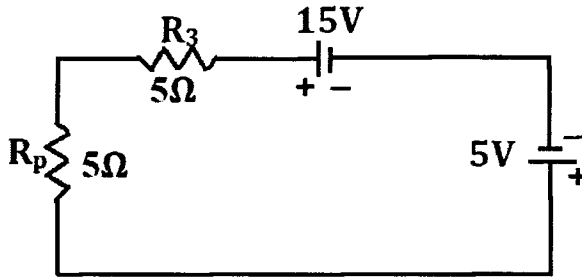
v) Elasticity: It is the property of a material to regain its original shape after the removal of load. When a material is subjected to an external load of such magnitude that deformation continues only with increase in load, and on removing the load it regains its original shape, then the material is said to have elasticity.

5. Determine the current I of the following circuit.



Solution:

R_1 and R_2 is in parallel, so $R_p = \frac{R_1 R_2}{R_1 + R_2} = \frac{10 \times 10}{10 + 10} = 5\Omega$



Now, R_p and R_3 is in series.

$$R_5 = 5 + 5 = 10\Omega$$

Net Voltage, $V = 15 - 5 = 10V$

$$\therefore I = \frac{V}{R} = \frac{10}{10} = 1A \text{ (Answer)}$$

Non-Departmental

বাংলা

১. এক কথায় প্রকাশ করঃ হাতির ডাক- বৃহিত
২. “আমার ভাইয়ের রক্তে রাঙ্গানো একুশে ফেব্রুয়ারি” গানের রচয়িতা কে? - আব্দুল গাফফার চৌধুরী
৩. মুজিব বর্ষের সময়কাল- ১৭মার্চ, ২০২০-১৬ ডিসেম্বর, ২০২১
৪. কনসার্ট ফর বাংলাদেশের ইংল্যান্ড এর শিল্পী কে? - জর্জ হ্যারিসন
৫. ত্রিা পদের মূল অংশকে কি বলে?- ধাতু

English

1. What is the plural form of “Ox”? - Oxen
2. Translation: চোরটা হাতে নাতে ধরা পড়ল - The thief was caught red handed.
3. Voice: He had killed the snake.
4. Correction: The students have gone to see the Himalay.
- Correct form: The students have gone to see the Himalayas.
5. Interrogative sentence

Math

1. $a^4 + a^2b^2 + b^4 = a^2 + ab + b^2 = 3$ হলে $a^2 + b^2$ এর মান নির্ণয় কর।

BR-Power Generation Company Limited

Post: Assistant Engineer(Mechanical)

Date: 29.01.2021

Exam Hall: MIST

[Marks Distribution: Departmental-40 Non Departmental-60]

Departmental-40

1. Draw the schematic diagram and T-S diagram of combined cycle power plant.

Answer: Already discussed in several job solutions.

2. Heat is transferred to a heat engine from a furnace at a rate of 80 MW. If the rate of waste heat rejection to a nearby river is 50 MW, determine the net power output and the thermal efficiency for this heat engine.

Solution: power output, $P = 80 - 50 = 30\text{MW}$ and $\eta = \frac{30}{80} = 37.5\%$ (Answer)

3. The cross-sections of two solid bars made of the same material are shown in the figure. The square cross-section has flexural (bending) rigidity I_1 , while the circular cross-section has flexural rigidity I_2 . Both sections have the same cross-sectional area. What are the flexural rigidity and the ratio of the flexural rigidity?

Solution: Let the side of square cross-section = a and diameter of the circular cross section d .
Flexural rigidity = EI .

$$\text{Here, } a^2 = \frac{\pi}{4} d^2$$

$$\text{For Square section, } EI_1 = E \times \frac{a^4}{12}$$

$$\text{For circular section, } EI_2 = E \times \frac{\pi d^4}{64}$$

[Since, the material is same, so $E_1 = E_2 = E$]

$$\therefore \frac{I_1}{I_2} = \frac{\frac{a^4}{12}}{\frac{\pi d^4}{64}} = \frac{(a^2)^2/12}{\left(\frac{\pi}{4}d^2\right)^2 \times \frac{1}{4\pi}} = \frac{A^2}{A^2} \times \frac{4\pi}{12} = \frac{\pi}{3} \text{ (Answer)}$$

4. If x is the distance measured from the leading edge of a flat plate, then show that laminar boundary layer thickness varies with $x^{1/2}$.

$$\text{Solution: For laminar flow, } \delta = \frac{5x}{\sqrt{Re_x}} = \frac{5x}{\sqrt{\frac{\rho vx}{\mu}}} = \frac{5\sqrt{x}}{\sqrt{\frac{\rho V}{\mu}}} \therefore \delta \propto \sqrt{x}$$

5. A car engine with a power output of 65hp has a thermal efficiency of 24 percent. Determine the fuel consumption rate of this car if the fuel has a heating value of 44,000 kJ/kg.

$$\text{Solution: } \eta = \frac{65 \times 746}{\text{Input power}} \text{ or, } P_i = \frac{65 \times 746}{0.24} = 202.04166 \text{ KJ/s}$$

$$\text{Fuel consumption} = \frac{202.04166}{44000} = 4.59 \times 10^{-3} \text{ kg/s} = 16.53 \text{ kg/hr}$$

6. A centrifugal pump is required to pump water to an open water tank situated 4km away from the location of the pump through a pipe of diameter 0.2m, having Darcy's

friction factor 0.01. The average speed of water in the pipe is 2m/s. If it is maintained a constant head of 5m in the tank, neglecting other minor losses, find the absolute pressure at the pump exit.

Solution: [see BR-powergen-2019 question]

7. List the gases which are emitted from an automobile engine and effects on human health and environment.

Sulphur Oxides (SO_x): It causes respiratory illness, but occurs only in very low concentrations in exhaust gases. Further oxidation of SO_x forms H₂SO₄ and thus acid rains.

Nitrogen Oxides (NO_x): Nitrogen oxides contribute to the formation of ground level Ozone and acid rain.

Hydrocarbons and Volatile Organic Compounds (HC and VOC): Hydrocarbons result from the incomplete combustion of fuels. Their subsequent reaction with the sunlight causes smog and ground level Ozone formation. VOCs are a special group of Hydrocarbons. They are divided into 2 types methane and non methane. Prolonged exposure to some of these compounds (like Benzene, Toluene and Xylene) may also cause Leukemia.

Carbon Dioxide (CO₂): It is an indicator of complete combustion of the fuel. Although it does not directly affect our health, it is a greenhouse gas which causes global warming.

Carbon Monoxide (CO): It is a product of the incomplete burning of fuel and is formed when Carbon is partially oxidized. CO is an odorless, colorless gas, but is toxic in nature. It reaches the blood stream to form Carboxyhemoglobin, which reduces the flow of Oxygen in blood.

Lead (Pb): It is a malleable heavy metal. Lead present in the fuel helps in preventing engine knock. Lead causes harm to the nervous and reproductive systems. It is a neurotoxin which accumulates in the soft tissues and bones.

Particulate Matter (PM): These are tiny solid or liquid particles suspended in gas (soot or smoke). Particulate Matter in higher concentrations may lead to heart diseases and lung cancer.

8. A vibratory system consists of a mass 12.5 kg, a spring of stiffness 1000 / N m, and a dash-pot with damping coefficient of 15 /Ns m. Find the value of critical damping of the system.

Solution: Given, $m=12.5\text{Kg}$, $K=1000\text{N/m}$, $c=15\text{Ns/m}$.

We get, critical damping, $c_c = 2\sqrt{mk} = 2\sqrt{1000 \times 12.5} = 223.6\text{Ns/m}$ (Answer)

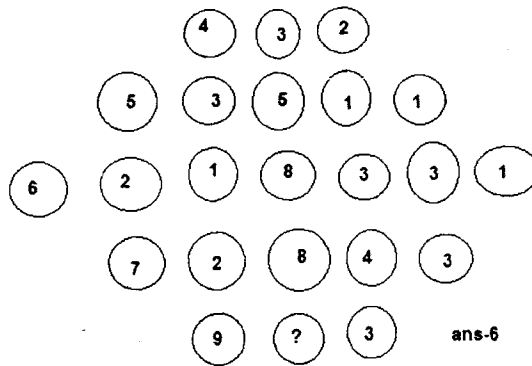
Non departmental-60

- আগরতলা ষড়যন্ত্র মামলার অফিসিয়াল নাম কি – State vs. Sheikh Mujibur Rahman and others
- ১৭ এপ্রিল, ১৯৭১ এর তাৎপর্য কি- মুজিব নগর সরকারের শপথ গ্রহণ এবং স্বাধীন বাংলাদেশের ঘোষণাপত্র পাঠ
- Passive form of ‘who can touch the sky’ – By whom the sky can be touched?
- SCDA meaning- supervisory control and data acquisition/Source computer data application.
- When Bangladesh energy regulatory commission established- 2004
- First waste based power plant in Bangladesh – Jolkuri, narayanganj

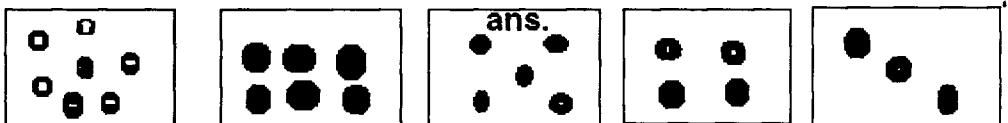
7. What is the mission and vision of BR-Power generation company limited
8. Location of two submarine cable by BREB is- sondip(chattogram) and naria(shariatpur)
9. At how many places transmission line from India entered Bangladesh- Tripura(India)- Cumilla(BD)
10. Half-life of U-235 is – 703.8 million years
11. How many layers in nuclear reactor- five layers
১২. বাগধারা: মুগলি কায়দা-রাজকীয় , কাঠকড়ি গণা-নিষ্কর্মা বসে থাকা
১৩. ত্বরিত শব্দের দুইটি বিপরীতার্থক শব্দ-ধীর, স্থির
১৪. পদ্মা নদীর মাঝি উপন্যাসের লেখক ও প্রধান পুরুষ চরিত্র-মানিক বন্দ্যোপাধ্যায়, কুবের
১৫. "বিশ্বের যা কিছু মহান সৃষ্টি চির কল্যাণকর অর্ধেক তার করিয়াছে নারী অর্ধেক তার নর" - কার লেখা এবং রচনাটির নাম-কাজী নজরুল ইসলাম, নারী কবিতা
১৬. "কপোতাক্ষ নদ" কোন ধরনের রচনা এবং এর একটি বিশেষ বৈশিষ্ট্য- কবিতা, দেশাত্ববোধ
১৭. বাক্য শুদ্ধিকরণ-অनावश्यक ব্যাপারে কৌতুহল থাকা ভালো নয়- অনাবশ্যক ব্যাপারে কৌতুহল ভালো নয় ; শুধুমাত্র এ কটা টাকা দিলে-শুধু/মাত্র এই কটা টাকা দিলে?
18. He passed himself----- as a rich & Novel fellow(fill in the gap)
19. একজন ট্রাম্প কালভাদ্রে একবারই জন্মে (translation)
২০. আরাকান রাজ্য কখন রাখাইন রাজ্য নামকরণ হয়-১৯৯০
21. How much time required to take three tablets in the interval of half hour- 60 minutes
২২. বঙ্গবন্ধু কতদিন কারাগারে ছিলেন- ৪৬৮২দিন
23. What is zionism?
24. Balfour declaration- (The Balfour Declaration was a public statement issued by the British government in 1917 during the First World War announcing support for the establishment of a "national home for the Jewish people" in Palestine, then an Ottoman region with a small minority Jewish population)
25. In which year New Capital of myanmar was declared?-2006 (naypyitaw)
26. who won the nobel peace prize along with nelson Mandela?-Federik William de klerk
27. who bowled highest number in Cricket- muralitharan
28. Who is the man of the series in Bangabandhu T20 cup?-mustafizur rahman
29. Name of the Rohingya mass killing operation-operation nagamin
30. Four people need to cross a rickety bridge at night. Unfortunately, they have only one torch and the bridge is too dangerous to cross without one. The bridge is only strong enough to support two people at a time. Not all people take the same time to cross the bridge. Times for each person: 1min, 2min, 7min and 10mins. What is the shortest time needed for all four of them to cross the bridge?-17mins.
31. Seven airline flights -101,102,103,104,105,106,107 are to be scheduled for departure, one at a time on the hour, from 9am until 3pm. The schedule must conform to the following requirements:
A. Flight 101 must depart at 9am.

- B. Flight 105 must depart later than flight 103 and also later than flight 102.
 C. Flights 104,106 and 107 must depart on consecutive hours in that order.
- 1) If flight 107 is scheduled to depart at noon, flight 105 must be scheduled to depart at:10am/11am/1pm/3pm.
 - 2) If flights 103 and 104 are scheduled to depart at 11am and 12 noon respectively, then flight 102 must be scheduled to depart at: 9am/10am/1am/2am.
 - 3) Which of the following lists three flights in sequence from first to last in which they could be scheduled to depart consecutively?
 101,104,103/102,103,106/104,105,106/106,107,103
 - 4) If flight 106 is scheduled to depart at 2 pm, flight 105 must be scheduled to depart at-
 10am/11am/12pm/1pm

32.



33.



Bangladesh Power Development Board (BPDB)**Post: Assistant Engineer(Mechanical)****Time-03.00PM to 04.00PM****Date:26.02.2021****Exam Hall: BUET****[Marks Distribution: Departmental-60 Non Departmental-40]****Non departmental-40****Bangla**

1. সঠিক বানান- পুণ্য
2. বসন্তে ফুল ফোটে- বসন্তে কোন কারক-অধিকরণ কারক
3. ষ-ত্ব বিধান বহির্ভূত- ভাষা/অফিস/দুস্কর
4. শাস্ত্রত বঙ্গ কার লেখা-কাজী আব্দুল ওদুদ
5. কোনটি তদ্ভব শব্দ-হাত
6. মণীষার বিপরীত শব্দ-নির্বোধ
7. সাধু ও চলিত ভাষার পার্থক্য কোন পদে বিদ্যমান- ক্রিয়া ও সর্বনাম পদে
8. যিনি বরণের যোগ্য-বরণ্য
9. অধিকাংশের মতে বাংলা ভাষার উৎপত্তি কোন শতকে - অষ্টম শতকে
10. বাংলা স্বরবর্ণে দীর্ঘস্বর বর্ণ কয়টি- ৬ টি (দীর্ঘস্বর ধ্বনি - ৭টি)

Mathematics

1. Find the nth term of the sequence :5,2,-1,-4,-7,..... Answer: **8-3n**
2. $Y = 4x$ is the equation of a line which passes through,
(a) y-axis (b) positive x-axis (c) **origin** (d) negative x-axis
3. When three dice are thrown simultaneously/randomly, thus number of event can be **-216**
(6^3)
4. The age of father 10 years ago was thrice the age of his son. Ten years hence, father's age will be twice that of his son. The ratio of their present ages is:
a. 5 : 2 b. **7 : 3** c. 9 : 2 d. 13 : 4
5. Difference of two odd number square is divisible by- **sum of them and subtraction of them**
6. If x and y are negative, then which of the following statements is/are always true ? **x/y is positive**
7. $1+2+3+....+49=? - 1225$
8. If $a^{2x+2}=1$ where a is positive real number other than 1. Then $x=?$ a. -2 b. **-1** c. 0
d. 1
9. What least value should be given to X so that the number 6342X1 is divisible by 3?
(a) 0 (b) 1 (c) **2** (d) 3
10. If the two side of the rectangle is 8 & 6 cm, then what will be the diagonal? **10cm**

General Knowledge

1. Bangabandhu safari park situated in - **Sreepur**

2. Who was the first commander of sector four- **Chitto Ranjon Datta.**
3. Which country related with 'water'-
4. How many ODI won by Bangladesh so far-**131**
5. EPZ started its operation from which year-**1983**
6. Birth place of birsrestho hamidur rahman- **Jinaidah**
7. What is the GDP growth in 2019-2020 fiscal year- **5.24%**
8. Father of www – **Tim burners lee**
9. Length of Padma bridge-**6.15km**
10. Water density measuring device- **Hydrometer**

English

1. Correct spelling- **miscellaneous**
2. Correct sentence- It is high time **he started the work.**
3. He can't **put up with** the noise in the class.
4. 'High handed' means- **oppressive**
5. Teacher judges students **by** their results.
6. Salt has been used for centuries as a method of preserving food. Here 'preserving means'- **Conserving**
7. Antonym of 'overstrung' – **calm**
8., I wouldn't have one.
9. Al Berunifonds **of**...
10. At last the beast in him got upper hand. Answer: **the**

Departmental

1. (a) Draw a schematic diagram of a vapor absorption refrigeration system and labels all the components.

Answer: Same as BITAC-2016

- (b) Draw P-V and T-S diagram of Rankine Cycle used in steam turbine.

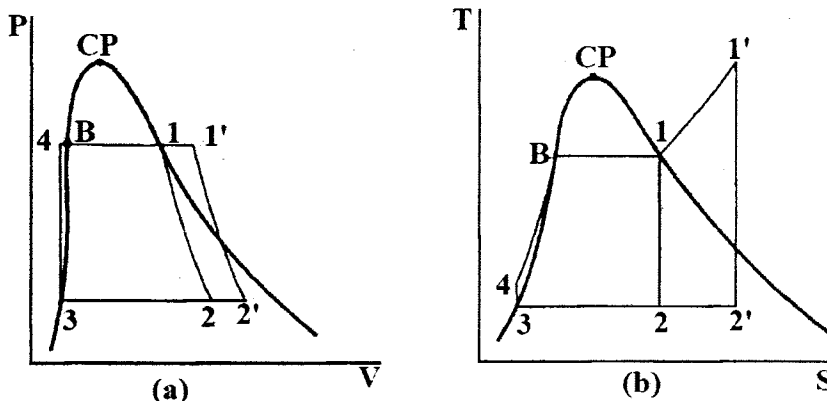
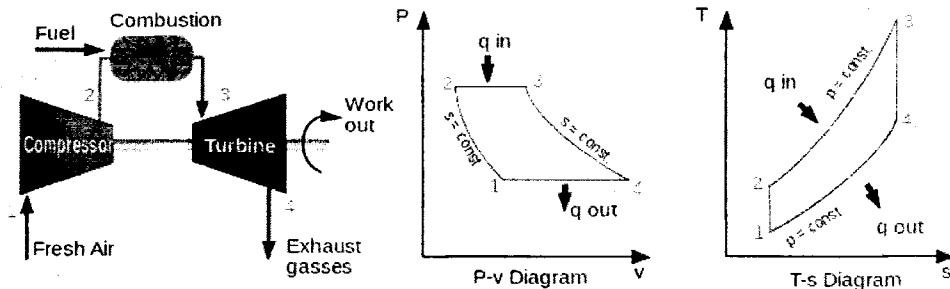


Fig.: Ideal Rankine cycles of the (a) P-V and (b) T-S diagrams. Line 1-2-3-4-B-1 = saturated cycle. Line 1'-2'-3-4-B-1' = superheated cycle. CP = Critical point

2. In an air standard cycle air enters into compressor at 1 bar and 20°C and leaves at 3.5 bar. At 600°C enters into the turbine. Find (a) Heat added per kg. (b) Efficiency of the cycle. Take $\gamma=1.4$ and $C_p=1.005\text{KJ/kg.K}$.



Solution: Given, $P_1=P_4=1$ bar, $P_2=P_3=3.5$ bar, $T_1=20+273=293\text{K}$, $T_3=600+273=873\text{K}$

We get, $\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$ or, $T_2 = 419.09\text{K}$;

Heat added per kg = $C_p(T_3 - T_2) = 456.17\text{KJ/Kg}$ (Answer)

and $\eta = 1 - \frac{T_1}{T_2} = 30.08\%$ (Answer)

3. a) In a belt arrangement two pulleys are connected by flat belts having same diameters. The maximum force on the tight side of belt is 600N. If co-efficient of friction is 0.3 then what is maximum force on the slack side of the belts?

Solution: Given, $T_1 = 600\text{N}$, $\theta = \pi$, $\mu = 0.3$, $T_2 = ?$

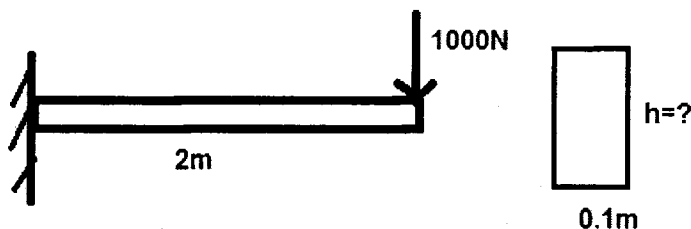
We get, $\frac{T_1}{T_2} = e^{\mu\theta}$

$\Rightarrow T_2 = 233.8\text{N}$ (Answer)

b) A 2.4m bar is placed between two rigid walls. The bar is stress free at 20°C . What will be the thermal stress at 30°C if co-efficient of thermal expansion is $1.2 \times 10^{-5}\text{m/m}^{\circ}\text{C}$ and $E=200\text{GPa}$?

Solution: $\sigma_{th} = \alpha E \Delta T = 1.2 \times 10^{-5} \times 200 \times 10^3 \times 10 = 24\text{MPa}$

4. A 2m long cantilever beam with point load at the end shown in figure. If maximum value of stress is 300MPa then what will be the minimum value of h?



Solution: $\sigma = 300 \times 10^6 = \frac{MC}{I} = \frac{1000 \times 2 \times \frac{h}{2}}{\frac{1}{12} \times 0.1 \times h^3}$ or, $h^2 = 4 \times 10^{-4} \therefore h = 0.02\text{m}$ (Answer)

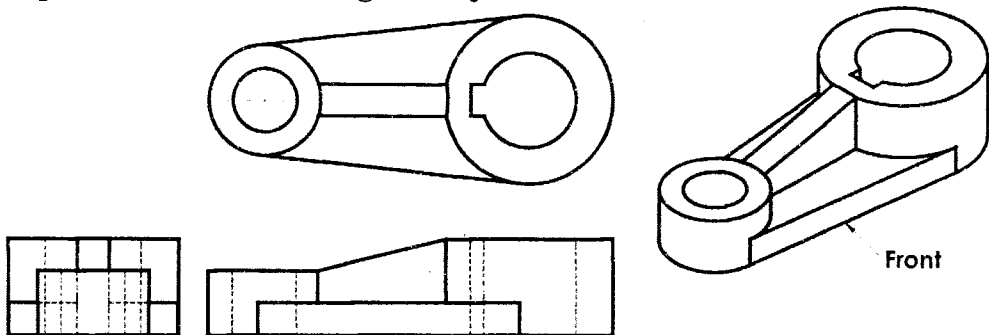
5. A turbine works under a head of 25m at 200rpm. The discharge through the turbine is $10\text{m}^3/\text{s}$. If the overall efficiency of the turbine is 91%, find the power generated by the turbine and the specific speed of the turbine.

Solution:

Power generated, $P = \eta \gamma QH = 0.91 \times 9.81 \times 10 \times 25 = 2231.775\text{KW}$ (Answer) and

specific speed, $N_s = \frac{N\sqrt{P}}{H^{5/4}} = \frac{200\sqrt{2231.775}}{25^{5/4}} = 169.01\text{rpm}$ (Answer)

6. Draw top and front view of the given object.



Bangladesh Ordnance Factory (BOF)

Post: Assistant Engineer(Mechanical)

Date:06.03.2021

[Marks Distribution: Departmental-60 Non Departmental-40]

Departmental

1. A projectile thrown from ground with an initial velocity of 240m/s towards at 3650m horizontal distance and 610m above the ground. Determine angle of projection with the ground.

Solution:

$$y = x \tan \theta - \frac{gx^2}{2u^2 \cos^2 \theta}$$

$$\begin{aligned} \text{or, } 610 &= 3650 \tan \theta - \frac{g \times 3650^2}{2 \times 240^2 \cos^2 \theta} = 3650 \tan \theta - \frac{g \times 3650^2}{2 \times 240^2} \sec^2 \theta \\ &= 3650 \tan \theta - \frac{g \times 3650^2}{2 \times 240^2} (1 + \tan^2 \theta) \end{aligned}$$

$$\text{or, } 1134.49 \tan^2 \theta - 3650 \tan \theta + 1744.49 = 0 \therefore \theta = 69.2^\circ \text{ or } 30.28^\circ$$

2. A liquid of specific gravity 0.9 and viscosity 20cp is flowing through an annulus formed of two concentric pipes at 10ft/s. The inner diameter of larger pipe is 2ft and the outer diameter of smaller pipe is 1.5ft. Find out Reynolds number.

Solution:

Given, $\rho = 0.9 \times 1000 = 900 \text{ kg/m}^3$, $\mu = 20 \text{ cp} = 20 \times 0.1 \times 10^{-2} \text{ Pa.s} = 0.02 \text{ Pa.s}$,
 $D_h = D_o - D_i = 2 - 1.5 = 0.5 \text{ ft} = 0.152 \text{ m}$, $u = 10 \text{ ft/s} = 3.04 \text{ m/s}$

$$\text{Re} = \frac{\rho u D_h}{\mu} = 20793.6$$

3. What are the factors affecting cutting tool efficiency.

- Cutting speed
- Physical properties of work piece
- Ratio of feed to depth of cut
- Shape and angles of tools
- Effect of lubricants
- Nature of cutting
- Coating of cutting tools

4. A boiler produces steam at the rate of 500kg/hr. The enthalpy of feed water is 400kJ/kg and enthalpy of steam is 2960kJ/kg. Latent heat of fusion is 2256kJ/kg. Determine the power of the boiler and evaporation factor.

Solution:

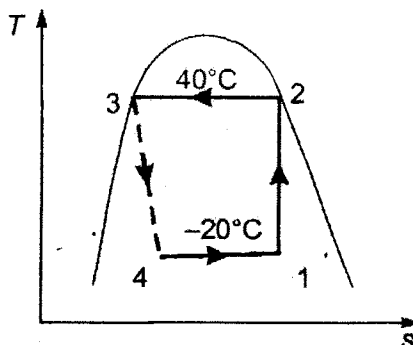
$$\text{Power, } P = m_s(h - h_f) = \frac{500}{3600} \times (2960 - 400) = 355.55 \text{ KW}$$

$$\text{Factor of evaporation} = \frac{h - h_f}{2256} = 1.134$$

5. A refrigerator based on ideal vapour compression cycle operates between the temperature limits of -20°C and 40°C . The refrigerant enters the condenser as saturated vapour and leaves as saturated liquid. The enthalpy and entropy values for saturated liquid and vapour at these temperature are given in the table below:

Temperature ($^\circ\text{C}$)	h_f (KJ/Kg)	h_g (KJ/Kg)	S_f (KJ/Kg)	S_g (KJ/Kg)
-20	20	180	0.07	0.7366
40	80	200	0.3	0.67

If the refrigerant circulation rate is 0.025Kg/s, what is the refrigeration effect and COP of the refrigerator?

Solution:

$$S_1 = S_2 = S_{g2} = S_{f1} + x_1(S_{g1} - S_{f1}) \text{ or, } 0.67 = 0.07 + x_1 \times (0.7366 - 0.07) \text{ or, } x_1 = 0.9$$

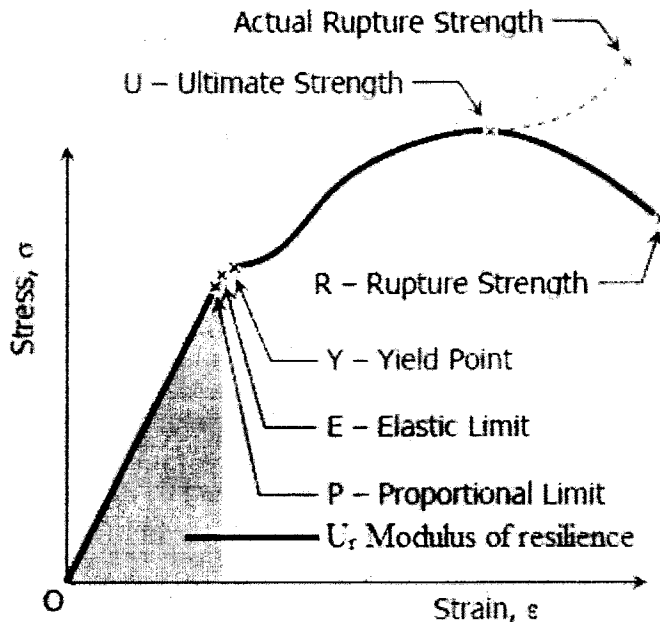
$$h_1 = h_{f1} + x_1 h_{fg1} = 20 + 0.9 \times (180 - 20) = 164 \text{ kJ/kg}$$

$$\therefore \text{Refrigeration effect} = m(h_1 - h_4) = 0.025(164 - 80) = 2.1 \text{ KW (Answer)}$$

$$\text{COP} = \frac{\text{Refrigeration effect}}{\text{Work input}} = \frac{2.1}{m(h_2 - h_1)} = \frac{2.1}{0.025(200 - 164)} = 2.33 \text{ (Answer)}$$

6. Draw the stress strain curve for ductile steel and showing proportional limit, yield strength, ultimate strength, breaking strength, modulus of rigidity and resilience.

Answer:



7. A diesel engine cylinder has piston diameter of 10cm. If stroke length is 15cm and clearance length is 1.3cm then what is the compression ratio?

Solution: Given, piston dia. $d = 10\text{cm}$, $L = 15\text{cm}$, clearance length = 1.3cm

$$V_s = \frac{\pi}{4} d^2 \times L = 1178.097 \text{ cm}^3 \text{ and } V_c = \frac{\pi}{4} 10^2 \times 1.3 = 102.1 \text{ cm}^3$$

$$\text{Compression ratio, } r = \frac{V_s + V_c}{V_c} = 12.54$$

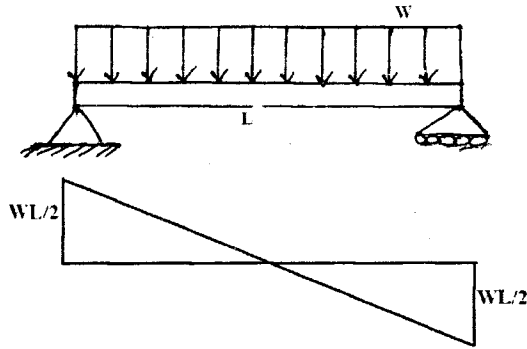
8. A diesel engine has brake power of 7HP. It consumes 50ml of fuel in 2 minutes and specific gravity of fuel is 0.84. Determine brake specific fuel consumption in g/bhp.hr.

$$\text{Solution: fuel consumption per hour, } m = \rho V = \frac{0.84 \times 1000 \times 50 \times 10^{-6}}{\frac{2}{60}} = 1.26 \text{ kg/hr}$$

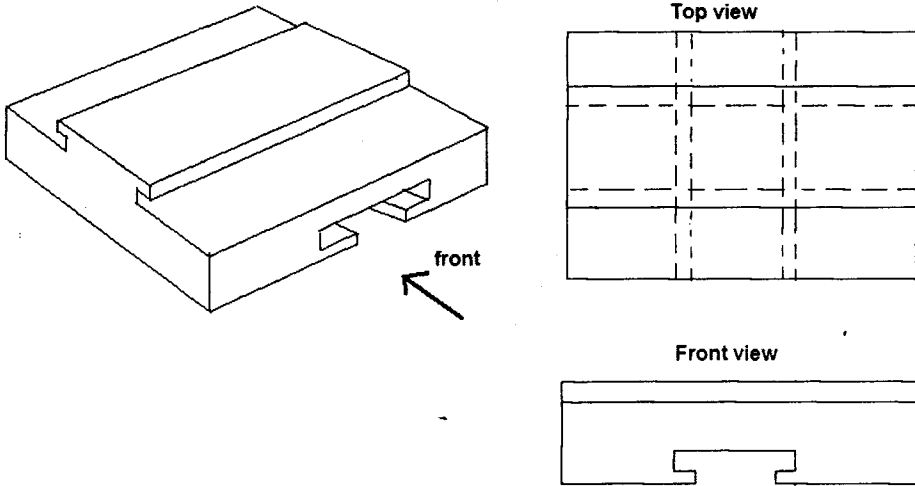
$$\text{Brake specific fuel consumption, Bsf} = \frac{1.26 \times 1000}{7} = 180 \text{ g/bhp.hr}$$

9. Draw the SFD of the following beam.

Answer: same as question-12 Ashuganj Power Station Company Ltd. (APSCCL)



10. Draw the top and front view.



Non departmental

১. বাংলা

বাগধারা: অর্থসহ বাক্য গঠন

আদায় কাঁচকলায়- শত্রুতা

অনুরোধে টেকি গলা- অনুরোধে দুরূহ কাজ করতে রাজি হওয়া

২. এক কথায় প্রকাশঃ

অকাল জাত কুশাস্তঃ একেজো

অথ পশ্চাৎ না ভেবে কাজ করে যে- অবিমৃশ্যকারী

৩. সন্ধি বিচ্ছেদঃ

সংসার= সম+সার

জনৈক= জন+এক

৪. শাহনামা গ্রন্থের লেখক কে?- পারস্যের বিখ্যাত কবি ফেরদৌসী

পথের পাঁচালী উপন্যাসের লেখক কে? বিভূতিভূষণ বন্দ্যোপাধ্যায়

৫. শূন্যস্থান পূরণঃ এ জগতে হায় যার আছে ভুরি ভুরি শাসন করা তারই সাজে সোহাগ করে যে।

Mathematics

১. নৌকার গতিবেগ ঘন্টায় ১৫কি.মি. শ্রোতের গতিবেগ ঘন্টায় ৫কি.মি.। ৩০ কি.মি. গিয়ে ফিরে আসতে মোট সময় কত?- ৪.৫ঘন্টা

২. কোন বর্গক্ষেত্রের ক্ষেত্রফল ১০০ বর্গমিটার। এর বাহুর দৈর্ঘ্য ১০% বৃদ্ধি পেলে এর বৃদ্ধির হার কত?- ২১% বৃদ্ধি পাবে।

English

1. Write short note on "Digital Bangladesh"

2. Filling the gaps with appropriate word:

I started__ Chattogram. She has no ability__ painting. Every member of my family __ here today. They as well as he __ wrong. Time and tides __ for none.

General knowledge

১. বাংলাদেশের স্বশস্ত্র প্রতিরোধ কবে ও কোথায় গড়ে তোলে? ১৯ মার্চ, ১৯৭১ গাজীপুরে

২. কারাগারের রোজনামাচার লেখক কে ও কত তারিখে প্রকাশিত হয়? বঙ্গবন্ধু শেখ মুজিবুর রহমান, প্রকাশিত হয় ২০১৭ সালে

৩. বাংলাদেশের জাতীয় নির্বাচনের আসন সংখ্যা ও সংরক্ষিত আসন কতটি? ৩০০ এবং সংরক্ষিত আসন ৫০টি

৪. জার্মানির প্রধানমন্ত্রী সমমর্যাদার পদ কোনটি ও সর্বপ্রথম মহিলার নাম কি? চ্যান্সেলর, এঙ্গেলা মার্কেল
৫. জাতিসংঘের সাধারণ অধিবেশনে কে সর্বপ্রথম বাংলায় ভাষণ দেয় ও কত তারিখে? বঙ্গবন্ধু শেখ মুজিবুর রহমান, ২৫ সেপ্টেম্বর, ১৯৭৪ সালের ২৯তম সাধারণ অধিবেশনে

Titas Gas Transmission and Distribution Company Limited (TGTDCL)

Post: Assistant Engineer(Mechanical)

Time-10.00AM to 11.00AM

Date:05.03.2021

Exam Hall: BUET

[Marks Distribution: Departmental-80, Non Departmental-40]

Non departmental-40

বাংলা

১. সঠিক বানান- আকাঙ্ক্ষা
২. কাজী নজরুল ইসলামের জন্মস্থান- চুরুলিয়া
৩. "সবার উপরে মানুষ সত্য, তাহার উপর নাই" উক্তিটি কার-চন্ডীদাস
৪. ভাষার ক্ষুদ্রতম একক- ধ্বনি
৫. ডোবা এর বিপরীত শব্দ- ভাসা
৬. নীল দর্পণ কার লেখা- দীনবন্ধু মিত্র
৭. অকূল পাথার বাগধারার অর্থ-ভীষণ বিপদ
৮. হাজার বছর ধরে উপন্যাস কার লেখা- জহির রায়হান

General Knowledge

1. Designation of Angela Merkel- chancellor
2. When first gas field discovered – 1955
3. 'Titas ekta nodir nam' who is the director of this movie- Rittik Ghotok
4. Which Olympic is cancelled due to corona – Tokyo 2020 (will begin 23 july, 2021)
5. Steve paul jobs involves with which company – Apple
6. First Bangladeshi received noble prize- D.M. Younus
7. Which Asian country never be colonized – Thailand

8. 'Simla agreement' signed between which two countries- Pakistan and India
9. Which organization first recognized corona-
10. Amsterdam stadium situated in-Netherlands

English

1. Correct spelling – denunciation
2. He said, "I have done the work" –indirect speech- He said that he had done the work.
3. Antonym of crass- sensitive
4. Preposition, article, fill the gap

Math

1. If $n_{th}=3n+4$ then summation of 12 terms-68
2. If $\log_x 81=4$ then $x=3$
3. If a sphere convert into cylinder volume will – remain unchanged
4. A box contains 4 green balls, 3 red balls. If one ball is drawn then what is the possibility to become red? – 3/7
5. 1.14 is a percent of 1.9 is -60%
6. Mean and standard deviation, interest, age, arithmetic series related math

Departmental

✓ 1. A cylindrical pressure vessel is fabricated from plating that has a thickness of 20mm. The diameter of pressure vessel is 450mm and its length is 2m. Determine maximum internal pressure that can be applied if longitudinal stress is limited to 140MPa and circumferential stress is limited to 60MPa.

Solution: $\sigma_c = \frac{PD}{2t}$ or, $P = \frac{60 \times 2 \times 20}{450} = 5.33 \text{ MPa}$ and $\sigma_1 = \frac{PD}{4t}$ or, $P = \frac{140 \times 4 \times 20}{450} = 24.88 \text{ MPa}$

Maximum internal pressure=5.33MPa

✓ 2. Steel railroad reels 10 m long are laid with a clearance of 3 mm at a temperature of 15°C. At what temperature will the rails just touch? What stress would be induced in the rails at that temperature if there were no initial clearance? Assume $\alpha = 11.7 \mu\text{m}/(\text{m} \cdot ^\circ\text{C})$ and $E = 200 \text{ GPa}$.

Solution: $\delta_T = \alpha L(T_f - 20)$

$\Rightarrow 3 = 11.7 \times 10^{-6} \times 10000 \times (T_f - 15)$

$\therefore T_f = 40.64^\circ\text{C}$ (Answer)

$\sigma_{th} = \alpha E \Delta T = 11.7 \times 10^{-6} \times 200 \times 10^3 \times (40.64 - 15) = 60 \text{ MPa}$ (Answer)

3. Draw schematic and T-S diagram of most efficient power plant cycle used in Bangladesh.

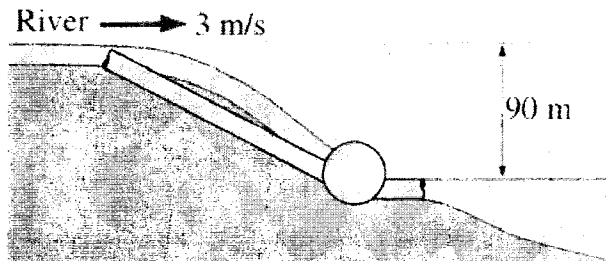
Answer: Same as Question-10 of Biman Bangladesh Airlines Ltd- 2018.

4. A glass window whose size is 1.2m × 2m × 0.006m. Thermal conductivity is 0.78w/mk and inside and outside temperature is 24°C and -5°C respectively. Co-efficient of convection of inner air and outer air films are 10w/m²K and 25w/m²K. Find the heat flux and draw the radiation network.

Solution: $\frac{Q}{A} = \frac{\Delta T}{\frac{x}{K} + \frac{1}{h_i} + \frac{1}{h_o}} = \frac{24 - (-5)}{\frac{0.006}{0.78} + \frac{1}{10} + \frac{1}{25}} = 196.35 \text{ W/m}^2$



5. Consider a river flowing toward a lake at an average velocity of 3 m/s at a rate of 500 m³/s at a location 90 m above the lake surface. Determine the total mechanical energy of the river water per unit mass and the power generation potential of the entire river at that location.



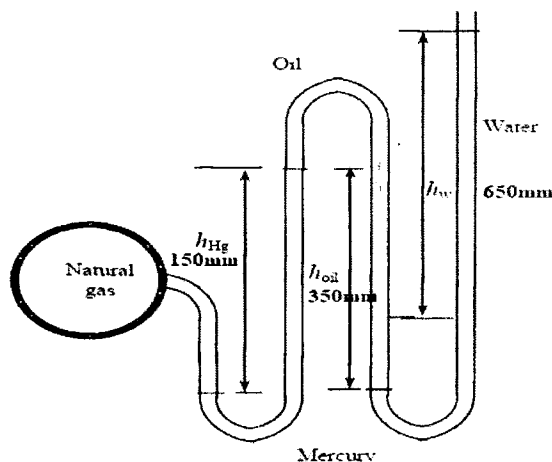
Solution:

Total mechanical energy,

$$e_{\text{mech}} = \frac{P}{\rho} + \frac{V^2}{2} + gh = 0 + 9.81 \times 90 + \frac{3^2}{2} = 887.4 \text{ J/Kg} = 0.8874 \text{ KJ/Kg (Answer)}$$

$$\dot{E} = \dot{m}e = \rho \dot{V}e = 1000 \times 500 \times 0.8874 = 443.7 \times 10^6 = 443.7 \text{ MW (Answer)}$$

6. The pressure in a natural gas pipeline is measured by the manometer shown in Fig. below with one of the arms open to the atmosphere where the local atmospheric pressure is 98 KPa. Determine the absolute pressure in the pipeline. SG of mercury is 13.6 and SG of oil is 0.69.



Solution: We get, $P_{\text{Ng}} = P_{\text{atm}} + P_{\text{Hg}} + P_{\text{water}} - P_{\text{oil}}$

$$P_{Ng} = 98000 + (13.6 \times 1000 \times 9.81 \times 0.15) + (1000 \times 9.81 \times 0.65) - (690 \times 9.81 \times 0.35)$$

$$P_{Ng} = 122019.8 \text{ Pa} = 122.02 \text{ KPa (abs.) (Answer)}$$

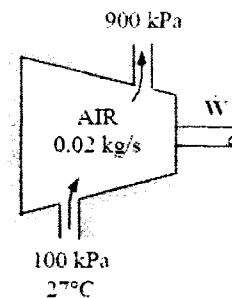
7. Air enters a compressor with a stagnation pressure of 100 kPa and a stagnation temperature of 27°C, and it is compressed to a stagnation pressure of 900 kPa. Assuming the compression process to be isentropic, determine the power input to the compressor for a mass flow rate of 0.02 kg/s.

Take $C_p = 1.005 \text{ KJ/kg.K}$ and $\gamma = 1.4$.

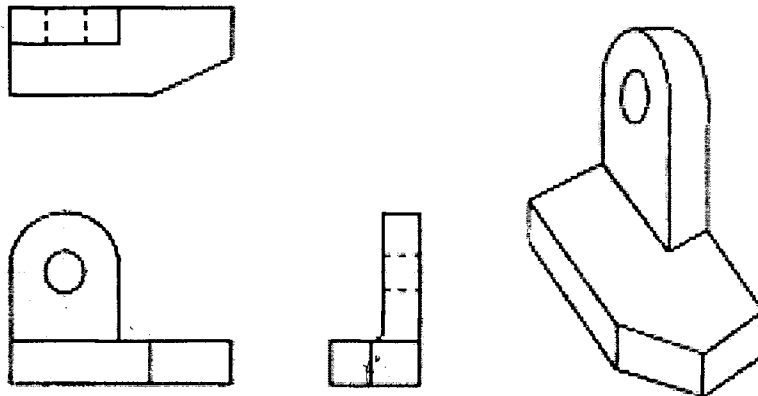
Solution: We get,

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} \text{ or, } T_2 = 300.2 \times \left(\frac{900}{100}\right)^{\frac{1.4-1}{1.4}} = 562.4 \text{ K}$$

$$\therefore \text{Power input to the compressor} = \dot{m} C_p (T_2 - T_1) = 0.02 \times 1.005 \times (562.4 - 300.2) = 5.27 \text{ KW (Answer)}$$



8. Draw the projection of the given figure in third angle projection.



Bankers Selection Committee (Sonali-Janata Bank Senior Officer)

Post: Senior Officer (Mechanical)

Time-10.00AM to 11.00AM

Date:25.09.2020

Exam Hall: Bangladesh Bank High School, Motijeel, Dhaka.

[Marks: Departmental-40, Bangla-10, English-10, Math-10, Gk-10]

বাংলা-১০

1. নায়ক এর প্রকৃতি প্রত্যয়- $\sqrt{\text{নে}} + \text{অক}$
2. কর্মই ধর্ম, কর্মেই মুক্তি
3. বাংলাদেশের প্রথম মহিলা ঔপন্যাসিকের নাম - স্বর্ণকুমারী দেবী (প্রথম উপন্যাস-দীপনির্বাণ)
4. 'ঐ' বর্ণটি কোন বর্ণদ্বয়ের মিলনে গঠিত - অ,ই
5. শব্দের ক্ষুদ্রতম অংশ - ধ্বনি
6. থিদে কোন ভাষার শব্দ - অর্ধ-তৎসম
7. 'অংশ' এর সমার্থক শব্দ - কুটুম
8. ষড়ঋতু এর স্বক্টিবিচ্ছেদ - ষট্+ঋতু
9. কোনটি দেশি শব্দ - টেঁকি
10. রাবনের চিতা এর বাগধারা - চির অশান্তি

English-10

1. Antonym of cease – start
2. Correct spelling – secretariat
3. Which is not an adjective – humour
4. 'Hit below the belt' means –Hurting or insulting someone in an inappropriate way/ too personal
5. Preposition
6. It will not be boring to ___ the same story from you again – be heard/hear/hearing
7. Which is the active voice of 'This picture was painted by Zaynul abedin – Zaynul Abedin painted this picture.
8. Conjecture is related to – guess.
9. Abstract noun – boy/child/family/childhood.
10. Can't remember

Math-10

1. If $x + \frac{1}{x} = 4$ then $x^4 + \frac{1}{x^4} = ?$ Ans- 194
2. The production cost of a product is 10tk and selling price 16tk. If in the process of selling 10000tk more spend then how many product need to sell to make 50000tk profit.

Solution: Let, x number of product need to sell. Then production cost of x number of product is $10x$ taka.

Total cost $= (10x + 10000)$ taka, Total sale $= 16x$ taka, Now

profit $= 50000 = 16x - (10x + 10000)$

or, $x = 10000$ unit.

3. The capital of a person is 1200tk. He deposited some part of the money in bank at 5% interest and rest of the money at 7% interest. Total profit 72tk at the end of the year. How much profit earned from 5% interest. (didn't get exact question)

Solution: Let, deposited money x and y at 5% and 7% respectively. According to question, $x + y = 1200$ and $0.05x + 0.07y = 72$, By solving these equations- $x = 600$, $y = 600$. Profit from 5% interest $= 0.05 \times 600 = 30$ tk

4. The side length of a square inscribed in a circle is 2. What is the area of the circle?



Diameter $= \sqrt{(2^2 + 2^2)} = 2\sqrt{2}$; $r = \sqrt{2}$, area $= \pi r^2 = 2\pi$

5. X varies inversely as square of y . Given that $y = 2$ for $x = 1$, the value of x for $y = 6$ will be _.

Solution: $x = k \cdot \frac{1}{y^2}$ or, $1 = k \cdot \frac{1}{2^2}$ or, $k = 4$. Now, for $y = 6$, $x = \frac{4}{6^2} = \frac{1}{9}$

6. $a^x = b$, $b^y = c$, $c^z = a$. $xyz = ?$ Solution: $a^x = b$ or, $x \log a = \log b$, similarly, $y \log b = \log c$ & $z \log c = \log a$; $x \log a = \frac{\log c}{y}$ or, $xy \log a = \log c = \frac{\log a}{z}$ or $xyz = 1$

7. Compound interest related large math.

8. Loss profit related math

9-10. can't remember

General knowledge-10

1. 'Doing business' সূচকে বাংলাদেশের অবস্থান কত? উত্তর: ১৬৮
2. 'জাতিসংঘ' ধারণার প্রবক্তা কে? উত্তর: উড্রু উইলসন
3. ক্রোয়েশিয়ার প্রেসিডেন্ট কে? উত্তর: Zoran milanovic
4. ২০১৯ সালে ফিজিক্স এ নোবেল পেয়েছেন কে? James peedbles
5. বঙ্গবন্ধু আনুষ্ঠানিকভাবে কখন ছয় দফা দাবি উত্থাপন করেন? উত্তর: ২৩ মার্চ, ১৯৬৬
6. মিয়ানমার থেকে কতটি নদী বাংলাদেশে প্রবেশ করেছে? উত্তর: ৩টি (নাফ, মাতামুহুরি ও সাজু)
7. বিশ্ব স্বাস্থ্য দিবস কবে? উত্তর: ৭ এপ্রিল
8. সাম্প্রতিক বাজেটে কোন খাতে বাজেটের পরিমাণ বেশি? উত্তর: জনপ্রসাশন
9. বাংলাদেশে সেবা খাতে কর্মসংস্থান হার? উত্তর: ৩৯%
10. সবচেয়ে বেশিদিন মহাকাশে কে কাটিয়েছে? উত্তর: Valery Polyakov(438days) and among womens Christina Koch(328days).

Departmental- 40

1. Bronze is an alloy of- **copper and tin.**
2. Manganese is added in low carbon steel in order to – make the steel tougher and harder/raise the yield point/**make the steel ductile and of bending good qualities/all of above**
3. The percentage of carbon in low carbon steel-**0.15%**
4. Reactors for propulsion applications use –**enriched uranium/molten lead/any form of uranium/thorium**
5. The undesirable property of a refrigerant is – **High boiling point**
6. Coulomb friction is the friction between- **two dry surfaces**
7. The desirable property of a refrigerant is – low boiling point/high critical temperature/high latent heat of vaporization/**all of above.**
8. Engine pistons are made of alluminium alloys because it- **is lighter/wear is less/absorbs shocks/is stronger.**
9. The reason for supercharging in any engine is to – increase efficiency/**increase power/reduce weight and bulk for a given output/Effect fuel economy.**
10. The resultant of two equal forces 'P' making an angle θ is given by - $2P\sin\theta/2$; $2P\cos\theta/2$; $2P\tan\theta/2$; $2P\cot\theta/2$.
11. 11. Addition of heat to a constant pressure to a gas results in – **raising temperature and doing external work.**
12. 12. Morse test can be conducted for – petrol engine/diesel engine/**multicylinder engines/all of these.**
13. A hydraulic ram is used to – store the energy of water/increase the pressure of water/to lift water from deep wells/ **to lift small quantity of water to a greater height when a large quantity of water is available at a smaller height.**
14. According to the principle of buoyancy a body totally or partially immersed in a fluid will be lifted up by a force equal to – the weight of the body/ more than the weight of the body/less than the weight of the body/**weight of the water displaced by the body.**
15. Electrical motors converts- **Electrical to mechanical energy**
16. The compression ratio is always more than unity.
17. In a jet propulsion - **the propulsive matter is ejected from within the propelled body /the propulsive matter is caused to flow around the propelled body/its functioning does not depend upon presence of air/ none of the above.**

18. Temperature of the gases at the end of compression as compared to exhaust gases in a gas turbine is- higher/**lower**/equal/can't be compared.
19. All radiations in a black body are- reflected /refracted/transmitted/**absorbed**.
20. The amount of heat flow through body by conduction is – directly proportional of the surface area of the body /directly proportional to the temperature difference on the two surfaces of the body/depend upon the material of the body/**all of above**.
21. The carbide tools operating at the very low cutting speeds (below 30min/sec)- **reduces tool life**/increase tool life/have no effect on tool life/spoils the work piece.
22. High speed tools retain their hardness up to temperature of – 250/350/500/**900**.
23. The type of reamer is used for reaming operation in a blind hole , is – straight fluted reamer/left hand spiral fluted reamer/**right hand spiral fluted reamer**/any of these.
24. In TIG arc welding, the welding zone is shielded by an atmosphere of –

36. In which iron, the amount of carbon is maximum- nodular iron/cast iron/**pig iron**/wrought iron.
37. A sample of metal weighs 219gms in air, 180gms in water, 120gms in an unknown fluid. Then which is correct statement about density of metal- density of metal can't be determined/metal is twice as dense as water/metal will float in water/metal is twice as dense as unknown fluid.
- Solution: we know, $m = \rho v$, metal weighs 219gms in air, $0.219 = \rho_m V$ ---(1)
 Metal weighs in water 180gms- $0.18 = 0.219 - \rho_w V \Rightarrow \rho_w V = 0.039$ ----(2) Now, equation 2 divide by equation 1 we get, $\rho_m/\rho_w = 0.219/0.039 = 5.615 \Rightarrow \rho_m = 5.615 \rho_w$
 Similarly in unknown fluid, $0.12 = 0.219 - \rho_u V \Rightarrow \rho_u V = 0.099$ ----(3) Now, eqn (1)/(3) we get, $\rho_m = 2.212 \rho_u$
38. Which of the following is the locus of a point that moves in such a manner that its distance from a fixed point is equal to its distance from a fixed line multiplied by a constant greater than one- ellipse/**hyperbola**/parabola/circle.
- 39–40. can't remember.

Bangladesh Petroleum Institute (BPI)

Post: Scientific Officer

Time-One and half hours

Date:18.12.2020

[Marks Distribution: MCQ-30 Written-70]

MCQ-30

Bangla-9

- কোন বানানটি শুদ্ধ-**কুজ্জটিকা**/কুজ্জটিকা/কুজ্জটিকা/কুজ্জটিকা
- যুগ স্বন্ধিকালের কবি' বলা হয় কাকে-**ঈশ্বরচন্দ্র গুপ্ত**/কায়কোবাদ/সত্যেন্দ্রনাথ দত্ত/ফররুখ আহমদ
- 'কাজটা ভাল দেখায় না' এটি কোন বাচ্যের উদাহরণ-**কর্মকর্তৃবাচ্য**/কর্তৃবাচ্য/ভাববাচ্য/কর্মবাচ্য
- নিচের কোনটি তদ্ধিত প্রত্যয়- **ছাপা+খানা**/জন+অক/রাঁধ+উনি/কাঁদ+না
- 'প্রদীপ নিভে গেল' বাক্যটি কোন কালের- নিত্যবৃত্ত অতীত/**সাধারণ অতীত**/ পুরাঘটিত অতীত/ঘটমান অতীত
- মৌলিক শব্দ কোনটি-**গোলাপ**/শীতল/নেয়ে/গৌরব

7. 'সর্বাস্থে ব্যাথা, ঔষধ দিব কোথা' এই বাক্যে ঔষধ কোন কারকে কোন বিভক্তি-কর্মকারকে শূণ্য/সম্প্রদানে সপ্তমী/অধিকরণে শূণ্য/কর্তৃকারকে শূণ্য
8. খাঁটি বাংলা উপসর্গযোগে সৃষ্ট শব্দ কোনটি- আঁকড়া/অবেলা/অপমান/অতিশয়
9. কোন বাক্যটি প্রযোজক ক্রিয়া দ্বারা গঠিত- তোমার পরিশ্রমের ফল ফলেছে/মাথা ঝিম ঝিম করছে/শিশুটি কাঁদে/মা শিশুকে হাসান

English-9

1. Javed truly wanted to serve in the position no one else wanted; his enthusiasm was-counterfeit/negated/convoluted/**sincere**
2. As the day wore on with little progress in evidence, Jenny's energy began to-dissemble/**wane**/proliferate/mitigate
3. After a month of survival training in the wilderness, the scours became quite-lucid/putrefied/**alert**/odious
4. Being able to afford this luxury car will maximize/recombinant/**necessitate**/reiterate getting a better paying job
5. He will be arriving quite late, so by the time he comes, the play - would have begun/will begun/**will have begun**/would begun
6. The antonym of COERCIVE is- progressive/opilonated/promoting/**gentle**
7. Synonym of ALTRUISTIC- **benevolent**/progressive/inhumane/selfish
8. Select the correct spelling of the word-acquainttanc/**acquaintance**/acquaintance/acquaintance
9. Choose the correct pair of words from the following; symphony:composer-leonardo:music/**fresco:painter**/colours:pallet/art:appreciation

Mathematics-6

1. A swimming pool is initially filled to a depth of 96 inches. After 2 weeks, the depth has decreased to 92.5 inches. Assuming that the depth decreased at a constant rate, after how many days would the water depth have reached $93 \frac{3}{4}$ inches? 3/9/7/6

Answer: 9

2. In the coordinate plane, line m passes through the origin and has a slope of 3. If points (6,y) and (x,12) are on line m, the y-x=? 14/18/22/26 **Answer: 14**
3. A delivery cart went from candleford to lark rise and back at an average speed of $\frac{2}{3}$ miles per hour. If the distance from candleford to lark rise is 1 mile, and the trip back took half as much time as the trip there, what was the average speed of the delivery cart on the way to lark rise? $\frac{1}{3}, \frac{3}{4}, \frac{1}{2}, \frac{2}{3}$

Answer: $\frac{1}{2}$

4. The average of several exam scores is 80. One make up exam was given, included with the other scores, the new average was 84. If the score on the make up exam was 92, how many total exams were given? 3/2/4/5 **Answer: 3**

5. $h=3a+28.6$, a pediatrician uses the model above to estimate the height b of a boy, in inches, in terms of the boy's age a in years, between the ages of 2 and 5, based on the model, what is the estimated increase in inches of a boy's height each year?

7.5/10/3/5 **Answer: 3**

6. A television with a price of \$300 is to be purchased with an initial payment of \$60 and weekly payments of \$30. Which of the following equations can be used to find the number of weekly payments as required to complete the purchase, assuming there are no taxes or fees? $300=30w-60/300=30w/300=30w+60/300=60w-30$ **Answer: $300=30w+60$**

General Knowledge-6

- Which country has the highest energy consumption per capita in the world? - **USA/Iceland/UK/Saudi Arabia**
- Which of the following is not considered to be a source of renewable energy? – **hydropower/wind/natural gas/solar**
- Who is the author of the book Principia mathematica? - **Isaac Newton/Albert Einstein/galileo/Copernicus**
- Who has won US open 2020 men's singles title? – **rafael nadal/dominic thiem/novak djokovic/roger Federer**
- Who won the Nobel prize 2020 in literature? – **louise glick/petter handke/olga tkarczuk/kauo ishiguro**
- What is the name of the currency of Latvia? – **lira/euro/dollar/pound**

Written ability test

Bangla-20

- সাম্প্রতিক বন্যায় আপনার এলাকার গ্যাস লাইনটি ক্ষতিগ্রস্ত হয়েছে। এ বিষয়ে বিস্তারিত জানিয়ে সংশ্লিষ্ট কর্তৃপক্ষকে একটা চিঠি লিখুন।
- Translate the following into Bangla:
Today marks the 49 years of our existence as sovereign nation. On this day in 1971, our struggle for independence following a nine-month war was rewarded with a richly deserved victory that came at the cost of unimaginable loss of life and persecution. We should always remember with a deep sense of gratitude, the enormous contributions of the freedom fighters who fought and bled on the ground and the leading role of Bangabandhu and his four trusted lieutenants in steering us to this moment. Together their efforts and sacrifices, as well as that of countless other individuals both at home and abroad, paved the way for the fulfillment of the Bengali dream for self-determination.

English-20

- Fashion trend are difficult to follow these days and it is widely believed that they primarily exist just to sell clothes. Some people believe that we should not follow

them and that we should dress in what we like and feel comfortable in. To what extent do you agree or disagree with this opinion? You should write at least 200 words. Use your ideas, knowledge and experience and support your arguments with examples and with relevant evidence.

Mathematics -10

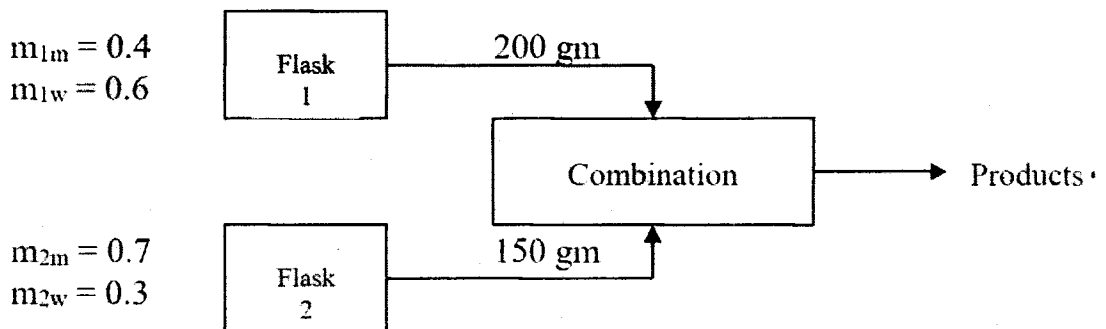
1. A shopkeeper buys 100 mangoes at tk. 12 each. He sells 60 mangoes at tk. 17.4 each and x mangoes at tk.11.31 each. The shopkeeper makes a profit of at least 10%. Find the least possible value of x.
2. A train has a length of 150 meters. It is passing a man who is moving at 2km/hour in the same direction of the train, in 3 seconds. Find the speed of the train.

Subjective Questions-20

Instructions: Answer any two of the following questions.

1. Two methanol-water mixture are contained in separate flasks. The first mixture contains 40 wt% methanol, and second contains 70 wt% methanol. If 200g of the first mixture is combined with 150g of the second, what are the mass and composition of the product?

Solution:



Here, Input = Output

$$m_{Tm} (\text{In}) = 0.4 \times 200 + 0.7 \times 150 = 185\text{gm} = m_{Tm} (\text{Out})$$

$$m_{Tw} (\text{In}) = 0.6 \times 200 + 0.3 \times 150 = 165\text{gm} = m_{Tw} (\text{Out})$$

$$\therefore m_{Tp} = m_{Tm} + m_{Tw} = 185 + 165 = 350\text{gm} \text{ (Answer)}$$

$$\% \text{ of composition of methanol} = \frac{m_{Tm}}{m_{Tp}} \times 100\% = \frac{185}{350} \times 100\% = 52.9\% \text{ (Answer)}$$

$$\% \text{ of composition of water} = \frac{m_{Tw}}{m_{Tp}} \times 100\% = \frac{165}{350} \times 100\% = 47.1\% \text{ (Answer)}$$

2. In a fluid pipeline, the flow has the following conditions at section 1: 25°C, 2atm, 15m/s velocity and 1m inside diameter of pipe. At section 2 the conditions are: 25°C, 1atm, and 2m inside diameter of pipe. Calculate the velocity at section 2.

Solution: Given, $d_1 = 1\text{m}$; $P_1 = 2\text{atm}$; $V_1 = 15\text{m/s}$; $d_2 = 2\text{m}$; $P_2 = 1\text{atm}$; $V_2 = ?$

We get from Bernoulli's equation: $\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$

$$\Rightarrow \frac{202650}{1000 \times 9.8} + \frac{15^2}{2 \times 9.81} = \frac{101325}{1000 \times 9.8} + \frac{V_2^2}{2 \times 9.81}$$

$V_2 = 20.68 \text{ m/s}$ (Answer)

3. Calculate the density of the gas mixture at standard conditions (300°K, 1atm, Z factor=1), whose composition is listed in the following table:

Component	Molecular weight	Composition(mole fraction)
Gas#1	10	0.8
Gas#2	20	0.1
Gas#3	30	0.1

Solution:

We get, $m = m_1 + m_2 + m_3 = n_1 M_1 + n_2 M_2 + n_3 M_3 = 0.8 \times 10 + 0.1 \times 20 + 0.1 \times 30 = 13$

$$\text{Density} = \frac{\text{mass}}{\text{Volume}} = \frac{13}{V_1 + V_2 + V_3} = \frac{13}{\frac{8.314 \times 300}{101.325} (0.8 + 0.1 + 0.1)} = 0.53 \text{ Kg/m}^3 \text{ (Answer)}$$

4. (a) What is well logging? Name different types of well logging.

Answer: The systematic recording of rock properties and it's fluid contents in wells being drilled or produced to obtain various petrophysical parameters and characteristics of down hole sequences (G.E Archie 1950). The measurement versus depth or time, or both, of one or more physical properties in a well. These methods are particularly good when surface outcrops are not available, but a direct sample of the rock is needed to be sure of the lithology.

Types of Well Logging Logs can be classified into several types under different category:

- Permeability and lithology Logs
- Gamma Ray log
- Self-Potential [SP] log
- Caliber log Porosity Logs
- Density log
- Sonic log
- , Neutron log Electrical Logs
- Resistivity Log

- (b) What is the importance of drilling muds? What is shale gas? Explain shale gas extraction procedure and why shale gas extraction has created controversy?

Answer:

Importance of drilling muds: Drilling fluid is any fluid that is used in a drilling operation in which that fluid is circulated or pumped from the surface, down the drill string, through the bit and back to the surface via the annulus. Drilling mud is necessary to:

1. Remove cuttings from the well.
2. Control formation pressure.
3. Suspend and release cuttings.
4. Seal permeable formations.
5. Maintain well bore stability.
6. Minimize reservoir damage.
7. Cool, lubricate and support the bit and drilling assembly.
8. Transmit hydraulic energy to tools and bit.
9. Ensure adequate formation evaluation.
10. Control corrosion.
11. Facilitate cementing and completion.
12. Minimize impact on environment.
13. Prevent gas hydrate formation.

Shale gas: Shale gas is a form of natural gas (mostly methane), found underground in shale rock. It is classified as 'unconventional' because it is found in shale, a less permeable rock formation than sandstone, siltstone or limestone in which 'conventional' gas is found, and it is generally distributed over a much larger area. It does not flow easily.

Shale gas extraction procedure: Hydraulic fracturing – commonly known as fracking – is the process used to extract shale gas. Deep holes are drilled down into the shale rock, followed by horizontal drilling to access more of the gas reserves, as shale reserves are typically distributed horizontally rather than vertically. Fracking fluids containing sand, water and chemicals are then pumped at high pressure into the drilled holes, to open up fractures in the rock, enabling the trapped gas to flow through the fractures into collection wells. From there it is piped away for commercial use. Recovery rates for shale gas are much lower than for conventional gas.

Shale gas extraction has created controversy: Fracking uses huge amounts of water, which must be transported to the site at significant environmental cost. As well as earth tremor concerns, environmentalists say potentially carcinogenic chemicals may escape during drilling and contaminate groundwater around the fracking site. The industry suggests pollution incidents are the results of bad practice, rather than an inherently risky technique.

5. Explain the following volcanic eruptions: Hawai'ian, Strombolian, Vulcanian and Plinian eruptions.

Answer:

Hawaiian eruption:

A Hawaiian eruption is a type of volcanic eruption where lava flows from the vent in a relatively gentle, low level eruption; it is so named because it is characteristic of Hawaiian volcanoes. Typically they are effusive eruptions, with basaltic magmas of low viscosity, low content of gases, and high temperature at the vent. Very small amounts of volcanic ash are produced.

Strombolian eruption:

A Strombolian eruption is a type of volcanic eruption with relatively mild blasts, having a Volcanic Explosivity Index of about 1 to 3. Strombolian eruptions consist of ejection of incandescent cinders, lapilli, and lava bombs, to altitudes of tens to a few hundreds of metres.

The eruptions are small to medium in volume, with sporadic violence. This type of eruption is named for the Italian volcano Stromboli.

Vulcanian eruptions:

A Vulcanian eruption is a type of volcanic eruption characterized by a dense cloud of ash-laden gas exploding from the crater and rising high above the peak. They usually commence with phreatomagmatic eruptions which can be extremely noisy due to the rising magma heating water in the ground. This is usually followed by the explosive clearing of the vent and the eruption column is dirty grey to black as old weathered rocks are blasted out of the vent.

Plinian eruptions:

Plinian eruptions or Vesuvian eruptions are volcanic eruptions marked by their similarity to the eruption of Mount Vesuvius in 79 AD, which destroyed the ancient Roman cities of Herculaneum and Pompeii. Plinian/Vesuvian eruptions are marked by columns of volcanic debris and hot gases ejected high into the stratosphere, the second layer of Earth's atmosphere. The key characteristics are ejection of large amount of pumice and very powerful continuous gas-driven eruptions.

6. The drive shaft in an automobile delivers 200Nm of torque as it rotates at 3600rpm.

Calculate the horsepower delivered.

Solution:

We know, Power Transmitted = Torque \times angular speed

$$= T \times \omega = T \times \frac{2\pi N}{60} = 200 \times \frac{2\pi \times 3600}{60} = 75398.22 \text{ W} = 101.11 \text{ hp (Answer)}$$

7. An inventor proposes an engine that operates between 27°C warm surface layer of the ocean and a 10°C layer of a few meters down. The inventor claims that the engine produces 100KW by pumping 20kg/s of seawater. Is this possible?

Solution:

The maximum temperature drop for the seawater is 17°C. The maximum rate of heat transfer from the high-temperature water is then,

$$Q_H = \dot{m} c_p \Delta T = 20 \times 4.18 \times 17 = 1421 \text{ KW}$$

The efficiency of the proposed engine is then,

$$\eta = \frac{W}{Q_H} = \frac{100}{1421} = 0.0704 \text{ or, } 7.04\%.$$

The efficiency of a Carnot engine operating between the same two temperatures is

$$\eta = 1 - \frac{T_L}{T_H} = 1 - \frac{283}{300} = 0.0567 \text{ or, } 5.67\%$$

The proposed engine's efficiency exceeds that of a Carnot engine; hence, the inventor's claim is impossible.

Bangladesh Bank(BB)
Post: AD(Mechanical)
Time-10.00AM to 12.00AM
Date:27.10.2020

Exam Hall: Lalmatia Girls High School

[Marks Distribution: MCQ-(20×1.5=30) Departmental (written)-170]

Part B-170

1. (a) Define 3rd law of thermodynamics. What is its importance and limitation?

3rd law of thermodynamics: The entropy of perfect crystal at absolute zero is exactly equal to zero.

Importance of third law of thermodynamics: It defines the sign of the entropy of any substance at temperatures above absolute zero as positive and it provides a fixed reference point that allows us to measure absolute entropy of any substance at any temperature. It helps to calculate the thermodynamic properties and to measure chemical affinity. It explains the behavior of the solids at very low temperature and also analyze the chemical and phase equilibrium.

Limitations: Glassy solids even at 0K have entropy greater than zero. Solids having mixtures of isotopes do not have zero entropy at 0K. For instance, entropy of solid chlorine is not zero at 0K. Crystals of CO, N₂O, NO, H₂O etc. do not have perfect order even at 0K thus their entropy is not equal to zero.

(b) Difference between heat transfer and thermodynamics.

Thermodynamics is concerned with equilibrium state of matter, precludes the temperature gradient and Heat transfer concerned with non-equilibrium process, temperature gradient must need for heat transfer.

Thermodynamics helps to determine the quantity of work and heat interaction when system changes one equilibrium state to another. Heat transfer refers us to determine the time rate at which interaction occurs.

(c) What is the significance of entropy?

Significance of entropy: The measure of level of disorder in a closed but changing system, a system in which energy can only be transferred in one direction from an ordered state to a disordered state. Higher the entropy higher the disorder level and lower the availability of the systems energy to do useful work. It can be used to predict whether a given process is thermodynamically possible or not.

2. (a) Define Newton's law of viscosity.

Newton's law of viscosity states that the shear stress between adjacent fluid layers is proportional to the negative value of the velocity gradient between the two layers.

The ratio of shear stress to shear rate is a constant, for a given temperature and pressure, and is defined as the viscosity or coefficient of viscosity.

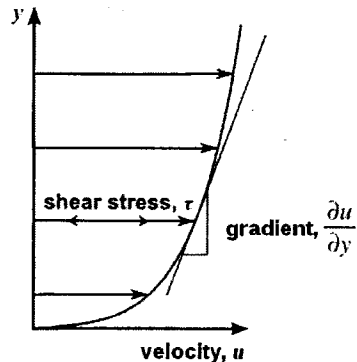
$$\tau \propto -\frac{du}{dy}$$

$$\tau = -\mu \frac{du}{dy}$$

Where, μ = Viscosity,

τ = Shear stress

$\frac{du}{dy}$ = Velocity gradient/ rate of shear deformation



(b) A beaker is filled with liquid of 1L volume and the weight is 6.5N. What is the specific weight?

$$W = mg = \rho Vg \text{ or } \rho g = \frac{W}{V} \therefore \gamma = \frac{6.5}{1 \times 10^{-3}} = 6.5 \text{ kN/m}^3$$

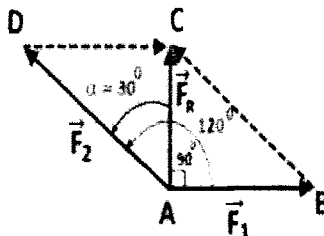
(c) Which is more efficient, centrifugal or reciprocating pump? Why centrifugal is not a positive displacement pump? Why centrifugal is known as high discharge pump?

Answer: Actually, the pump efficiency depends on their application. Positive displacement pump is more efficient than a centrifugal pump in terms of delivery pressure, because positive displacement pump has low discharge and high head. In terms of discharge, the centrifugal pump is more efficient.

Centrifugal pump is not a positive displacement pump: A positive displacement pump provides a constant flow at fixed speed, regardless of changes in pressure. The pump makes the fluid move by trapping a fixed amount and forcing the volume into the discharge pipe. The liquid flows into the pump as the cavity on the suction side opens or expands, while the liquid flows into the discharge as the cavity closes or decreases. Through every cycle of operation, the volume is the same. But in case of centrifugal pump the discharge depends on the suction pressure and there is a leakage in the impeller so the discharge flow varies and it is not a positive displacement pump.

Centrifugal pump uses the centrifugal force to push out the fluid. So the liquid entering the pump receives kinetic energy from the rotating impeller. The centrifugal action of the impeller accelerates the liquid to a high velocity, transferring mechanical (rotational) energy to the liquid. So it discharges the liquid in high rate.

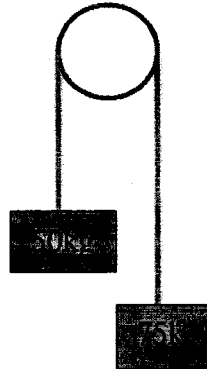
3. (a) Two forces act at an angle of 120° . Magnitude of larger force is 50kgf. The resultant force is perpendicular to the smaller force. What is the magnitude of smaller force?



We get, $\sin 30 = \frac{F_1}{F_2}$

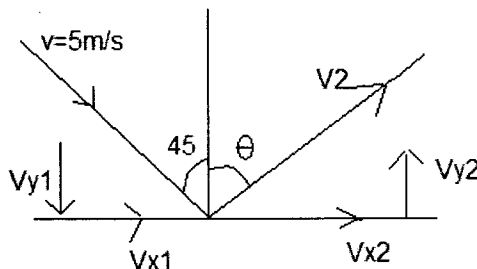
$\Rightarrow F_1 = 50\text{Kgf} \times \frac{1}{2} = 25\text{Kgf (Answer)}$

(b) What is the tension in the rope?



$T = \frac{2m_1m_2}{m_1+m_2}g = 588.6\text{N (Answer)}$

(c) A ball is moving to a 45° inclined surface at a velocity of 5m/s . Find the velocity after the impact. Line of action and impact line in same direction. Co-efficient of restitution is 0.5 .



$F_x = 0$ or, $mV_{x1} = mV_{x2} \therefore V_{x1} = V_{x2} = V\cos 45$

$= 3.53 \text{ m/s}; \text{ Co-efficient of restitution, } e = .5 = \frac{V_{y2}}{V_{y1}} = \frac{V_{y2}}{V\sin 45}$

$\therefore V_{y2} = 1.767\text{m/s}$

$\theta = \tan^{-1} \frac{V_{x2}}{V_{y2}} = \tan^{-1} \frac{3.53}{1.767} = 63.39^\circ$

Velocity after impact $= \sqrt{3.53^2 + 1.767^2} = 3.94\text{m/s (Answer)}$

4. (a) What is self-exciting generator? What is the advantage of parallel operation of generator? How the overheating of generator stator is prevented?

Self-exciting generator: A self-excited brushless alternator having a rotating field excited by an alternating current exciter whose armature rotates with the field winding of the alternator and is permanently connected to that winding by a rotating field rectifier.

Advantage of parallel operation of generator:

Continuity of Supply and Maintenance: This kind of connection is quite feasible when the repair and periodical maintenance work is concerned.

Efficiency: According to the efficiency versus load curve, generator efficiency is maximum when the load is 100%, so the generator unit must run on full load.

Size of Alternators: The higher the rating of the generator, the bigger the size of the setup will be.

Maximize Power System Reliability: If any one of the generators running in parallel is tripped due to fault, other parallel generators in the system will share the load.

The overheating of generator stator is prevented by keeping both the coolant and oil levels at their correct levels. By monitoring the exhauster to make sure that it is not blocked. By placing the generator in a protected but well-ventilated area.

(b) Briefly describe working principle of CNC machine. Describe how CNC machine revolutionized modern manufacturing process?

CNC system a dedicated computer is used to perform all the essential functions as per the executive program stored in the computer memory. The system directs commands to servo drives to drive the servo motor & other output devices like relays, solenoids, etc. to initiate the operations such as motor starting & stopping, coolant on & off, tool changing, pallet changing, etc. and other miscellaneous functions.

Once the system gives, it becomes necessary to ensure that the particular function has been completed. This is done by "Feed Back Devices." Continuous feedback device like linear scale, encoder, resolver, etc. are used as position feedback of the motor. Some sensors like proximity switch, limit switch, pressure switch, flow switch, and float switch, etc. are used as feedback devices to monitor the different operations. Thus all operations of the CNC machine are monitored continuously with appropriate feedback devices. So that CNC system is called as "Closed Loop" system. In case of failure in any failure feedback, the system generates a "Fault Message."

The principles of CNC operation.

Movement of X, Y, Z axis are controlled by a motor which supplies either Alternating current or Direct current.

Movement of the machine is done by giving commands.

All the operations are carried out by codes like speed, feed, depth of cut, etc.

For each operation separate code is available.

The warning system is available to save guard the various operations and components.

5. (a) What is the importance of thermostat in cooling system of IC engine? State whether specific humidity decrease or increase or remains constant during cooling and dehumidification.

The thermostat is like a valve that opens and closes as a function of its temperature. The thermostat isolates the engine from the radiator until it has reached a certain minimum temperature. Without a thermostat, the engine would always lose heat to the radiator and take longer to warm up.

The specific humidity decreases during cooling and dehumidification.

(b) Briefly describe cooling system of refrigerator and air conditioner. In a ammonia absorption refrigeration system which material is suitable as condenser coil-copper, aluminum, steel or brass?

Refrigerant vapor from the evaporator is compressed in a compressor and then cooled down to liquid phase in a condenser by exchanging heat with the ambient air. The liquid refrigerant is then throttled using an expansion device to lower its pressure and thus lowering its boiling point. This low pressure liquid refrigerant is then passed through the evaporator coil where it boils and becomes vapor by taking the latent heat from the objects / enclosure surrounding the evaporator coil and the cycle repeats.

In an ammonia absorption refrigeration system which material is suitable as condenser steel.

6. (a) Describe 'Just in time' system and 'Kanban' system in management system.

The just-in-time (JIT) inventory system is a management strategy that aligns raw-material orders from suppliers directly with production schedules. Companies employ this inventory strategy to increase efficiency and decrease waste by receiving goods only as they need them for the production process, which reduces inventory costs. This method requires producers to forecast demand accurately.

The JIT inventory system contrasts with just-in-case strategies, wherein producers hold sufficient inventories to have enough product to absorb maximum market demand.

The Kanban Method is a means to design, manage, and improve flow systems for knowledge work. The method also allows organizations to start with their existing workflow and drive evolutionary change. They can do this by visualizing their flow of work, limit work in progress (WIP) and stop starting and start finishing.

(b) Describe preventive, corrective, shut down and predictive maintenance of a lift in a busy building.

7. (a) Which method is more effective in fuzzy decision making among AHP, grey Decision Making and Intuitional Decision making method?

(b) What is SWOT analysis, Likert and AHP process?

Three Bank Combined (Sonali-Janata-RAKUB)**Post: Assistant Engineer.****Date: 20.10.2020****(20 mark bangla essay + 10 bangla to English translation + 10 English to bangla translation
+ 10 GK without option)****Department 150****Non-Departmental.**

বাংলা রচনা : করোনা মহামারীতে অর্থনৈতিক সংকট মোকাবিলায় করণীয়

Bangla to English অনুবাদ :

করোনা এবং Remittance নিয়ে একটা Passage

English to Bangla অনুবাদ:

গ্রামাঞ্চলে Internet এর অপ্রতুল ব্যবহার ও সীমাবদ্ধতা নিয়ে Passage

GK

১। কানাডার জাতীয় খেলা কোনটি?

২। সবচেয়ে ছোট মহাদেশ কোনটা?

৪। কবে East Pakistan থেকে বাংলাদেশ নামকরণ করা হয়?

৪। Cancass (এই রকম কিছু) এই পুরস্কার কোন ক্ষেত্রে দেয়া হয়?

৫। বর্তমানে মুদ্রাস্ফীতির হার কত?

৬। কোন একটা দিবসের (নাম মনে নেই) বর্তমান বছরের স্লোকান কী ছিল?

৭। মহিলা জাতীয় ক্রিকেট দলের ক্যাপ্টেনের নাম?

৮। জাতিসংঘ কবে নোবেল পুরস্কার পায় শান্তিতে?

Departmental

1. What is the Mechanical advantage of a Double Pulley?
2. Why is Over-pressurizing an air conditioning system bad?
3. How does a Super Charger work in a Car?
4. How can you see where pipes are behind the Wall?
5. How are the pneumatic system and the hydraulic system similar?
6. What is the difference Between an Electric motor and Electric Generator?
7. How is a Submarine able to Submerge and surface?
8. What is a Turboprop Engine?
9. What is the role of Nitrogen in welding?
10. What causes white smoke in two stroke Locomotive Engines?
11. What is the difference between hydraulic oil and engine oil?
12. Can you use motor oil in a hydraulic system?
13. What does angular momentum Mean?
14. What are different types of Gate valves?
15. What is supercharging?
16. State second law of thermodynamics.
17. Difference between petrol and diesel engine.
18. Structure, diagram and working principle of electric motor.
19. Which pipe is used for stream lines?
20. Write down the types of brake.

21. What is annealing?
22. Characteristics of mechanical refrigeration.
23. Define Torque.
24. What is Avogadro's law?
25. Basic characteristics of super critical boiler.
26. What are uses of compressed air in mechanical operations?
27. Importance of tolerance in mechanical production.
28. Can't recall.

বয়লার পরিদর্শক

পূর্ণমান-২০০

সময়-৪:০০ঘণ্টা (১৮.১১.২০১৯)

[প্রতিটি বিষয়ের জন্য পৃথক উত্তরপত্র ব্যবহার করুন]

বাংলা

ডবল কোডঃ ১০১ মানঃ ৪০

১. যেকোনো একটি বিষয়ে প্রবন্ধ রচনা করুন:

(ক) জাতির পিতার জন্মশতবর্ষ (খ) বাংলাদেশের উন্নয়নে তথ্যপ্রযুক্তি (গ) পদ্মাসেতু
(ঘ) বঙ্গবন্ধু স্যাটেলাইট-১ (ঙ) রোহিঙ্গা সমস্যার কারন ও সমাধানের উপায়

২. সারমর্ম লিখুন:

এসেছে নতুন শিশু, তাকে ছেড়ে দিতে হবে স্থান;

জীর্ণ পৃথিবীতে ব্যর্থ, মৃত আর ধ্বংসস্থপ-পিঠে।

চলে যেতে হবে আমাদের।

চলে যাব তবু আজ যতক্ষণ দেহে আছে প্রাণ

প্রাণপণে পৃথিবীর সরাবো জঞ্জাল,

এ বিশ্বকে এ শিশুর বাসযোগ্য করে যাব আমি

নবজাতকের কাছে এ আমার দৃঢ় অঙ্গীকার।

৩. রাজধানীতে ডেঙ্গুজ্বরের প্রকোপ নিরসনে ঢাকা সিটি কর্পোরেশনের (উত্তর অথবা দক্ষিণ-এর) সমীপে একটি পত্র লিখুন।

অথবা

একজন যুদ্ধহত মুক্তিযোদ্ধাকে আপনার মনের অনুভূতি জানিয়ে একখানা ব্যক্তিগত পত্র লিখুন।

৪. বাংলা অনুবাদ করুন:

A newspaper is a store-house of knowledge. We can know the conditions, manners, customs of other countries of the world from a newspaper. It is in fact the summary of all current history.

৫. যেকোনো দুটি প্রশ্নের উত্তর দিন:

(ক) ৭-ত্ব বিধান-এর ৫টি বিধান লিখুন।

(খ) বাংলা একাডেমি প্রণীত প্রমিত বানানের ৫টি নিয়ম লিখুন।

(গ) প্রদত্ত শব্দগুলোর শুদ্ধরূপ লিখুনঃ স্টাফ, কারন, দন্ড, স্টেশন, প্রশিক্ষন।

(ঘ) বাগধারাগুলোর অর্থসহ বাক্যরচনা করুনঃ কলুর বলাদ, সোনার পাথর বাটি, ডুমুরের ফুল, তালপাতারসেপাই, ননীর পুতুল।

English

1. Write an essay on any one of the following with given hints:

(a) ICT Education in Bangladesh

[Hints: Introduction- It's process of application- The importance of ICT learning- How to improve the efficiency- Merits of learning ICT - Conclusion]

(b) The Growing Importance of the Spirit of Liberation War of Bangladesh:

[Hints: Introduction- Background of Liberation War - The meaning of the spirit of Liberation War- Ever growing significance of the Liberation War- Conclusion.]

2. Write a letter to the Mayor of your city drawing his/her immediate attention to the indiscriminate dumping household waste in your locality and requesting him/her for taking appropriate measures.

or

Write a letter to your flat owner asking him/her for certain repairs to be done to your rented flat.

3. Read the following passage and answer the questions that follow:

The "Little Tramp", the unforgettable character Charlie Chaplin, was born purely by accident in 1915. While rushing to a film shoot in California, he grabbed clothes other people had left behind in the changing room. And when he emerged, he found he had created a personality everybody loved. A little guy in a bowler hat, a close-fitting jacket, a cane, outsize shoes and a brush-like moustache! Before long, Chaplin found himself a star. That puzzled him, for he saw himself essentially as a shy British Music Hall comedian. The U.S acknowledged him as its king of silent film comedy. Soon, so did crowds all over the world. But life wasn't always a laugh for Charles Spencer Chaplin. Both his parents Were Music Hall artists. Who separated when Charlie was very young. His childhood was very sad, for his mother never earned enough to look after Charlie and his older brother, Sydney. Sometimes, Chaplin had to sleep on the streets and forage for food in the garbage. Charlie took his first bow on stage when his mother made her last appearance. It happened when her voice broke during a song. Her son stepped on stage and sang a popular song. That's when a star was born. Through all these years of success, Charlie never forgot his troubled childhood. It made him recall a Christmas when he was denied two oranges and his bag of sweets for breaking a rule at the orphanage he went to after his mother's death. It would have broken his heart, if the other children had not offered him a share of theirs. Spontaneously, the adult Chaplin gifted the orphanage with a motion picture machine and insisted that each child should have a many oranges and sweets as they pleased.

Question:

- (a) What does the word 'acknowledge' mean in the passage?
- (b) Why wasn't the life always a laugh for Charlie Chaplin?
- (c) What was the name of the great character that was created by the renowned comedian Charlie Chaplin?
- (d) What were the reasons of Chaplin's disturbed childhood?

- (e) When was Chaplin born as a star?
4. Change the following sentences as directed:
- (a) Where was he born is not known to us (correct the sentence).
- (b) Young children are compared to Flowers (Make it active voice).
- (c) Karim said to me, "Let him say whatever he likes." (change the narration).
- (d) It was so noisy that we hear ___ ourselves speak. (Fill in the gap with the correct form of verbs).
- (e) The team got ___ carried when they won the championship and started shouting and throwing things around. (Fill in the gap)
- (f) The plane took ___ on time (Fill in the gap with correct preposition).
- (g) When he ___ (see) all the photographs, he will give those to me. (Fill in the gap with correct verb form)
- (h) Because of traffic jam, I could not attend the meeting in time. (Make it complex)
- (i) It was raining. He joined the party. (Join the two sentences)
- (j) He is as strong as you. (Make it comparative)

বাংলাদেশের বিষয়াবলি

১. বাংলাদেশ এর সংবিধান অনুসারে “রাষ্ট্র পরিচালনার মূলনীতি” এবং “মৌলিক অধিকার” এ দুটি বিষয়ে পার্থক্য নির্ণয় করুন।
২. “বাংলাদেশ ডেল্টা প্রান ২১০০” এর কয়েকটি বৈশিষ্ট্য সূচক দিক বর্ণনা করুন।
৩. বাংলাদেশের জনসংখ্যা রণানীর সমস্যা কী কী? সংক্ষেপে আলোচনা করুন।
৪. (ক) বাংলাদেশে বনভূমির পরিমাণ কত?
(খ) বনজ সম্পদের গুরুত্ব আলোচনা করুন।
৫. (ক) বঙ্গবন্ধুর ৭ মার্চের ভাষণে মুক্তিযুদ্ধের কী দিক নির্দেশনা ছিল তা সংক্ষেপে উল্লেখ করুন।
(খ) বঙ্গবন্ধু ও মুক্তিযুদ্ধ কর্নার কোন জেলায় স্থাপন করা হয়েছে?
৬. বাংলাদেশের শিক্ষানীতির মূল বৈশিষ্ট্য গুলো আলোচনা করুন।
৭. বাংলাদেশের যোগাযোগ ব্যবস্থায় যানজট রোধে আপনার সুপারিশ কী কী? যানজটের কারণে কী কী ক্ষতি হয়?

আন্তর্জাতিক বিষয়াবলি

৮. (ক) অর্থনৈতিক ও সামাজিক কাউন্সিল কী (ECOSOC)? (খ) এ কাউন্সিলের সদস্য সংখ্যা কত?
(গ) ECOSOC এর কাজ কী কী?
৯. বাংলাদেশের পররাষ্ট্রনীতিতে ভারত চীনের কী প্রভাব আছে বলে আপনি মনে করেন-লিখুন।
১০. রোহিঙ্গা সমস্যা সমাধানে চীনের গুরুত্ব আলোচনা করুন।
১১. SDG বাস্তবায়নে বাংলাদেশ সরকার কী কী উদ্যোগ গ্রহণ করেছে? কোন কোন আন্তর্জাতিক সংস্থা এতে সহায়তা করেছে?
১২. স্ক্যানডিনেভিয়ান দেশ গুলো কী কী? এ সকল দেশের সাধারণ বৈশিষ্ট্য কী কী?
১৩. চীন আমেরিকার বাণিজ্যিক দ্বন্দ্ব বিশ্ব শান্তির জন্য হুমকি হয়ে উঠতে পারে এ ব্যাপারে আপনার মতামত লিখুন।
১৪. (ক) “Annual Meeting of the New Champions 2019” কোথায় অনুষ্ঠিত হয়েছে?
(খ) এ সম্মেলনের বিষয়বস্তু (Theme) কী ছিল?

বিজ্ঞান ও প্রযুক্তি

১৫. WWW দিয়ে কী বুঝায়? এটি কত প্রকার?
১৬. কোন জাতীয় মশা ডেঙ্গু ছড়ায়? ডেঙ্গু বহনকারী জীবাণুর নাম কী?
১৭. e-Passport কী? এ পাসপোর্টের বৈশিষ্ট্য কী?
১৮. টিস্যু কালচার কী? এর ফলে কী কী সুফল পাওয়া যেতে পারে?
১৯. 4G এবং 5G এর মধ্যে পার্থক্য লিখুন।
২০. কোলেস্টেরল কী? এটি কত প্রকার ও কী কী?
২১. শীতকালে তাড়াতাড়ি কাপড় শুকায় কেন?

টেকনিক্যাল

1. (a) Why are water-tube boilers used for utility services?
(b) Differentiate between sub-critical boilers and super-critical boilers.
(c) In a boiler, feed water is supplied at a rate of 205 kg/hr. Net enthalpy rise of water is 145 kJ/kg for conversion to steam. If coal is consumed at 23 kg/hr having a calorific value of 2050 kJ/kg, calculate the efficiency of the boiler.
2. (a) Differentiate between conduction and convection modes of heat transfer.
(b) Define black-body. What is radiation shape factor?
(c) A hot ball of 3 cm diameter has a temperature of 727°C and an emissivity of 0.2. Determine how much energy is being emitted by the ball. Take $\sigma = 5.67 \times 10^{-8} \frac{W}{m^2} \cdot K^4$
3. (a) What is one 'ton' of refrigeration?
(b) What are some of the desired properties of a suitable refrigerant?
(c) With a block diagram describe the working principle of a vapor-compression refrigeration system.
4. (a) Differentiate between four-stroke and two-stroke internal combustion engines.
(b) What is 'compression ratio of an engine? How is the efficiency of a petrol or a diesel engine effected by it?
(c) A single-cylinder petrol engine has a clearance volume of 50 cc and a compression ratio of 11:1. Find its displacement volume and thermal efficiency.
5. (a) Write down the Bernoulli's equation and explain.
(b) Differentiate between laminar flow and turbulent flow.
(c) Define Reynolds number. What are the values of critical Reynolds number for external flows and internal flows to make transition from laminar to turbulent?
6. (a) Write down the specification of a lathe machine.
(b) Differentiate between drilling and boring.
(c) Define pattern. Name five allowances considered while designing a pattern.

Sylhet Gas Fields Limited (SGFL)

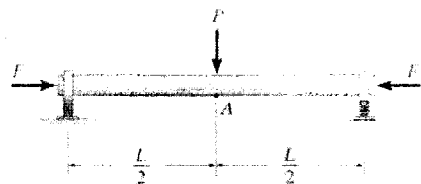
Date: 25.03.2021

Exam Hall: BUET

Departmental: $8 \times 5 = 40$; Non-dept.: $20 \times 1 = 20$

[Math = 5; GK = 5; = 5; Bangla = 5; English = 5]

1. The shaft has a diameter d and is subjected to the loadings shown. Determine the principal stress and the maximum in-plane shear stress that is developed at point A. The bearings only support vertical reactions. $P = 500\text{N}$; $F = 400\text{N}$; $d = 50\text{mm}$; $L = 400\text{mm}$.



Solution: Section Properties:

$$A = \frac{\pi}{4} d^2; I = \frac{\pi}{64} d^4$$

Normal Stress:

$$\sigma = \frac{N}{A} \pm \frac{MC}{I}$$

$$= \frac{-F}{\frac{\pi}{4} d^2} \pm \frac{\frac{PL}{2} \times \frac{d}{2}}{\frac{\pi}{64} d^4}$$

$$\sigma_A = \frac{4}{\pi d^2} \left(\frac{2PL}{d} - F \right)$$

Shear Stress: $\tau_A = 0$

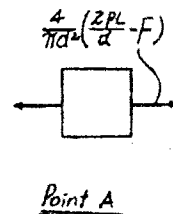
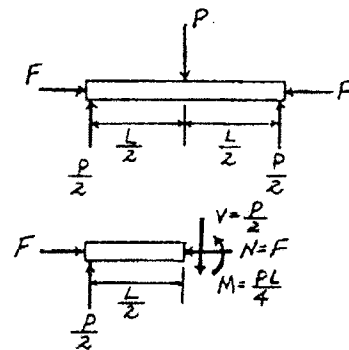
In plane principal stress:

$$\sigma_1 = \sigma_x = \frac{4}{\pi d^2} \left(\frac{2PL}{d} - F \right)$$

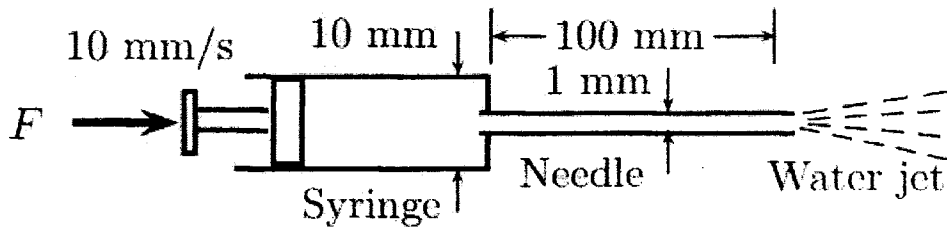
$$= \frac{4}{\pi (0.05)^2} \left(\frac{2 \times 500 \times 0.4}{0.05} - 400 \right)$$

$$\sigma_1 = 3.87\text{MPa (Answer)}$$

$$\sigma_2 = \sigma_y = 0 \text{ (Answer)}$$



2. A syringe with a frictionless plunger contains water and has at its end, a 100 mm long needle of 1 mm diameter. The internal diameter of the syringe is 10 mm. Water density is 1000 kg/m^3 . The plunger is pushed in at 10 mm/s and the water comes out as a jet.



Assuming ideal flow, Find the force F, in Newtons, is required on the plunger to push out the water.

Solution: Using subscripts 1 for syringe and 2 for needle: $d_1 = 0.01$ m, $d_2 = 0.001$ m, $l_2 = 0.1$ m,

$$\rho = 1000 \text{ kg/m}^3, v_1 = 0.01 \text{ m/s}$$

$$\text{Therefore, } V_2 = V_1 \left(\frac{d_1}{d_2} \right)^2 = 1 \text{ m/s}$$

The needle opens in atmosphere, therefore, $P_2 = 0$

Using Bernoulli's equation,

$$\frac{P_1 - P_2}{\rho g} = \frac{V_2^2 - V_1^2}{2g}$$

$$P_1 = 499.95 \text{ Pa}$$

Force required is:

$$F = P_1 \times \frac{\pi}{4} d_1^2 = 0.039266 \approx 0.04 \text{ N (Answer)}$$

3. An inventor claims that a new heat cycle will develop 0.4 kW for a heat addition of 32.5 kJ/min. The temperature of heat source is 1990 K and that of sink is 850 K. Is his claim possible?

Solution: Temperature of heat source, $T_1 = 1990$ K; Temperature of sink, $T_2 = 850$ K

Heat supplied = 32.5 kJ/min; Power developed by the engine, $P = 0.4$ kW

The most efficient engine is one that works on Carnot cycle

$$\eta_{\text{carnot}} = \frac{T_1 - T_2}{T_1} = \frac{1990 - 850}{1990} = 0.573 \text{ or } 57.3\%$$

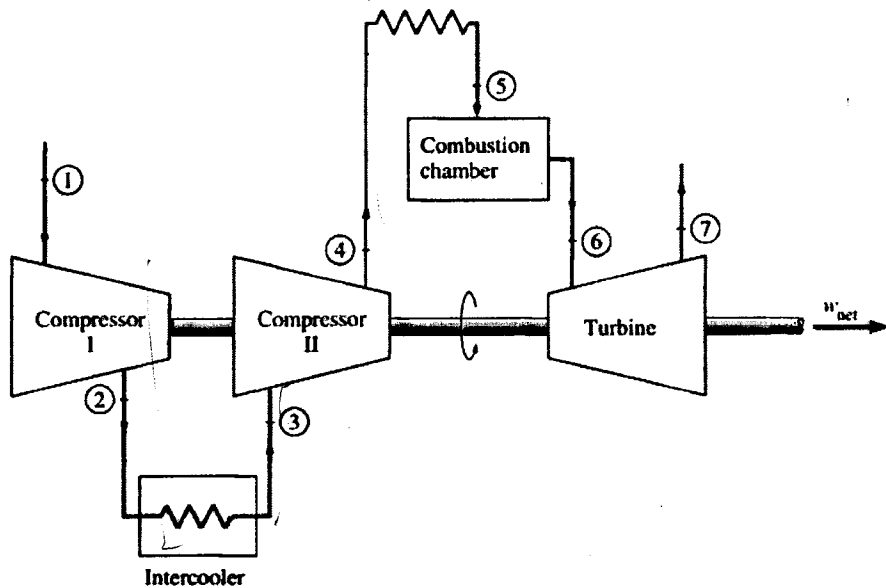
$$\text{Also, thermal efficiency of the engine, } \eta_{\text{th}} = \frac{\text{Work done}}{\text{Heat supplied}} = \frac{0.4}{\left(\frac{32.5}{60} \right)} = \frac{0.4 \times 60}{32.5}$$

$$= 0.738 \text{ or } 73.8\%$$

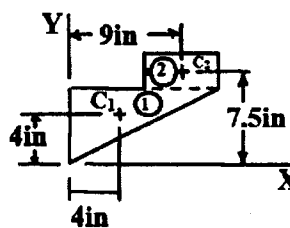
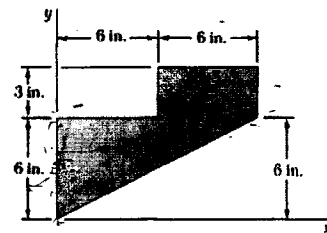
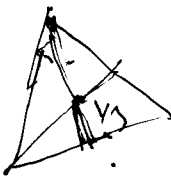
Which is not feasible as no engine can be more efficient than that working on Carnot cycle.

Hence claims of the inventor is not true.

4. Draw Schematic diagram of open loop gas turbine with intercooler.



5. Locate the centroid of the plane area shown.



	A, in^2	\bar{x}, in	\bar{y}, in	$\bar{x}A, \text{in}^3$	$\bar{y}A, \text{in}^3$
1	$\frac{1}{2}(12)(6) = 36$	4	4	144	144
2	$(6)(3) = 18$	9	7.5	162	135
Σ	54			306	279

Then

$$\bar{X}A = \Sigma \bar{x}A$$

$$\bar{X}(54) = 306$$

$$\bar{Y}A = \Sigma \bar{y}A$$

$$\bar{Y}(54) = 279$$

$$\bar{X} = 5.67 \text{ in. (Answer)}$$

$$\bar{Y} = 5.17 \text{ in. (Answer)}$$

6. (a) Draw a psychometric chart and schematically show the cooling process of room air in indoor split-type air conditioning system.

Solution: Question-4; Bangladesh Inland Water Transport Authority (BIWTA)-2019

(b) Drawing.

বিমান বাংলাদেশ এয়ারলাইন্স

28.02.2020

ক বিভাগ

১. বিমান বাংলাদেশ এয়ারলাইন্স লিমিটেড এর কেনা নিজস্ব উড়োজাহাজের সংখ্যা কত?
২. বিমান বাংলাদেশ এয়ারলাইন্স লিমিটেড বর্তমানে কতটি আন্তর্জাতিক রুটে ফ্লাইট পরিচালনা করে?
৩. ব্রাকের প্রতিষ্ঠাতা কে?
৪. বাংলাদেশ জাতিসংঘের কততম সদস্য?
৫. 'আমার ভাইয়ের রক্তে রাঙানো একুশে ফেব্রুয়ারি' গানটির সুরকার কে?
৬. চীনের উহান থেকে বিশ্বব্যাপী ছড়িয়ে পড়া করোনা ভাইরাসের কোড নাম কী?
৭. বাংলাদেশের কোন গবেষণা প্রতিষ্ঠান এবছর গবেষণার জন্য একুশে পদক পেয়েছে?
৮. ইংরেজি Attested এর বাংলা পরিভাষা কী?
৯. ইংরেজি Sibling শব্দের বাংলা অর্থ কী?
১০. শূন্যস্থান পূরণ করুন - You man go for a walk if you feel.....it.
১১. ইংরেজিতে অনুবাদ করুন - আজ জাতীয় পতাকা অর্ধনমিত থাকবে।
১২. ঢাকার দুই সিটি কর্পোরেশনের দুইজন মেয়রের নাম লিখুন?
১৩. বাংলাদেশে কয়টি আন্তর্জাতিক বিমানবন্দর রয়েছে?
১৪. TEUDATIT বর্ণগুলো দিয়ে একটি অর্থবহ শব্দ লিখুন।
১৫. ০.৩৩৩ এর সঙ্গে ৩.০০৩ গুণ করলে গুণফল কত হবে?
১৬. কোন বৃত্তের ব্যাস যদি ৮ সেমি হয় তবে তার পরিধি কত?
১৭. অহিনকুল কোন সমাস?
১৮. অর্থশাস্ত্রের জনক কে?
১৯. বিমান বাংলাদেশ এয়ারলাইন্স লিমিটেড এর মোবাইল এপস এর নাম কী?
২০. বিমান বাংলাদেশ এয়ারলাইন্স লিমিটেড এর বহরে সংযুক্ত হওয়া সর্বশেষ উড়োজাহাজ দুইটির নাম কী?
২১. বাংলাদেশের সাংবিধানিক নাম কী?

২৩. ১৯৭১ সালে মুক্তিযুদ্ধের সময় জাতিসংঘের কোন দেশ বাংলাদেশের পক্ষে ভোট দিয়েছিল?
২৪. টেস্ট ক্রিকেটে বাংলাদেশের পক্ষে সর্বোচ্চ রান সংগ্রহকারী ক্রিকেটার কে?
২৫. ক্ষন গণনায় জাতির পিতার জন্মশতবার্ষিকী শুরু হতে আর কতদিন বাকী আছে?
২৬. বায়োমেট্রিক্স কী?
২৭. শূন্যস্থান পূরণ করুন - The train is runningtime.
২৮. Voice change করুন - I invited him for a dinner.
২৯. ইংরেজি অনুবাদ করুন - "আমি তুমি এবং সে সবই উত্তরায় থাকি"।
৩০. ইংরেজি অনুবাদ করুন - "সে সাঁতার কাটতে জানে না"।
৩১. নোবেল পুরস্কারের প্রবর্তক কে?
৩২. BEZA এর পূর্ণরূপ কী?
৩৩. ভূমিকম্পের পরিমাপক যন্ত্রের নাম কী?
৩৪. কোন দেশকে ইউরোপের ককপিট বলা হয়?
৩৫. বায়ুর প্রধান উপাদান কী?
৩৬. ভারত বাংলাদেশকে স্বাধীন রাষ্ট্র হিসাবে কবে স্বীকৃতি প্রদান করে?
৩৭. ২০২০ বঙ্গবন্ধু গোল্ডকাপ ফুটবলের রানার আপ দলের নাম কী?
৩৮. বঙ্গবন্ধু স্যাটেলাইট-১ কোন শহর থেকে উৎক্ষেপন করা হয়?
৩৯. ফিফা বিশ্বকাপ ২০২২ কোন দেশে অনুষ্ঠিত হবে?
৪০. জাতিসংঘের বর্তমান মহাসচিবের নাম কী?
৪১. 'কারাগারের রোজনামচা'-র ভূমিকা কে লিখেছেন?
৪২. ১৭৫০ গ্রাম খেজুরের দাম ৭০০ টাকা হলে আধা কেজি খেজুরের দাম কত?
৪৩. বর্তমান অর্থ-বহরের বাংলাদেশের জাতীয় বাজেট কত?
৪৪. ইংরেজি অনুবাদ করুন - "বিমানের প্রতি যাত্রী সাধারণের আস্থা উত্তরোত্তর বৃদ্ধি পাচ্ছে"।
৪৫. গ্রিনপিস কোন দেশের পরিবেশবাদী সংগঠন?

২২. মুক্তিযুদ্ধভিত্তিক উপন্যাস 'রাইফেল রোট আওরাত' এর লেখক কে?	৪৬. বাংলাদেশের রঙিন টিভি সম্প্রচার কোন সালে শুরু হয়?
<p>৪৭. নাসাউ কোন দেশের রাজধানী?</p> <p>৪৮. বাংলাদেশ ক্রিকেটের কোন পর্যায়ে বিশ্ব চ্যাম্পিয়ন?</p> <p>৪৯. সার্কের বর্তমান সদস্য সংখ্যা কত?</p> <p>৫০. বাংলাদেশের জাতীয় সংসদের মাননীয় সদস্যগণের সংখ্যা কত?</p> <p>৫১. নেপালের প্রধানমন্ত্রীর নাম কী?</p> <p>৫২. বাংলাদেশের জাতীয় সংসদের মাননীয় স্পিকার এর নাম কী?</p> <p>৫৩. IATA এর BFCC পূর্ণরূপ কী?</p> <p>৫৪. জাতির পিতার জন্মশতবার্ষিকী উপলক্ষে বাংলাদেশ ব্যাংক কত টাকা মূল্যমানের ব্যাংক নোট প্রচলন করবে?</p> <p>৫৫. মেয়েদের চলমান ক্রিকেট বিশ্বকাপে গতকাল অনুষ্ঠিত বাংলাদেশ অস্ট্রেলিয়ার মধ্যকার ম্যাচে কোন দল জয়ী হয়েছে?</p> <p>৫৬. পানির উর্ধ্বচাপ বিবেচনায় কোথায় সাঁতার কাটা সহজ-নদীতে না সাগরে?</p> <p>৫৭. CNG এবং LPG বলতে কী বুঝায়?</p> <p>৫৮. বিশ্বের বৃহত্তম মুসলিম রাষ্ট্র কোনটি?</p> <p>৫৯. বাংলাদেশের জাতীয় পতাকার ডিজাইনার কে?</p> <p>৬০. কুয়েতের মুদ্রার নাম কী?</p>	<p>গ বিভাগ</p> <p>১. $\frac{1-ix}{1+ix} = a - ib$ হলে দেখাও যে, $a^2 + b^2 = 1$</p> <p>২. $(1+x)^2$ এর বিস্তৃতিতে $(r+1)$ তম এবং $(r+2)$ পদের সহগ দুইটি সমান হলে দেখাও যে, $2r = n - 2$</p> <p>৩. এক বিন্দুতে ক্রিয়ায় P ও Q দুইটি বলের লব্ধির মান R. যদি Q কে বিপরীতমুখী করা যায় তবে নতুন লব্ধি এক সমকোণ ঘুরে যায়। দেখাও যে, $P=Q$।</p> <p>৪. সাধারণ সমাধান নির্ণয় কর: $\sin x + \cos x = \sqrt{2}\sin 2x$</p>
<p>খ বিভাগ</p> <p>১. ভরকেন্দ্র এবং ভরকেন্দ্রের মধ্যে পার্থক্য কী?</p> <p>২. তরঙ্গ কাকে বলে? তরঙ্গ বেগ, তরঙ্গ দৈর্ঘ্য এবং কম্পাঙ্কেও মধ্যে সম্পর্ক কী?</p> <p>৩. বয়েল এবং চার্লস এর সূত্র বর্ণনা করুন এবং আদর্শ গ্যাসের সমীকরণ ব্যাখ্যা করুন?</p> <p>৪. তাপগতি বিদ্যার প্রথম সূত্রের তাৎপর্য গুলি লিখুন?</p>	

Chapter-15

BCS Question Bank

27th BCS

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MECHANICAL ENGINEERING

Subject Code:

9	0	1
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First Paper

Time Allowed-3 hours

Full Marks-100

[N.B. - Answer any five questions. The figures in the margin indicate full marks.]

- | | Marks |
|--|--------|
| 1. (a) What is a “thermodynamic process”? Distinguish between reversible and irreversible process. | 1+3=4 |
| (b) What is thermodynamic cycle? Distinguish between a four stroke cycle and a two stroke cycle. | 1+5=6 |
| (c) Draw Otto and Diesel cycle on P-V and T-S plane and indicate different processes on them. | 5+5=10 |
| 2. (a) How steam generator are classified? Distinguish between a fire tube and water tube boiler. | 8 |
| (b) What is meant by boiler accessories and boiler mountings? What are their functions? | 8 |
| (c) Discuss briefly: the working of an economizer in a boiler plant giving a neat sketch. | 4 |
| 3. (a) Explain the following terms in connection with design of machine member subjected to variable load:- (i) Endurance limit. (ii) Size factor. (iii) Surface finish factor. (iv) Notch sensitivity. | 4×2=8 |
| (b) Discuss the various types of power threads. Give their relative advantages and disadvantages. | 2+4=6 |
| (c) What is equivalent length of a column? Write the relation between the equivalent length and actual length of a column for various condition. | 2+4=6 |
| 4. (a) Draw stress-strain diagram for brittle and ductile material and indicates important points on them. | 4+4=8 |
| (b) A thin cylinder pressure vessel of 500 mm diameter is subjected to an internal pressure 2 N/mm ² . If the thickness of the vessel is 20 mm, find the hoop stress, longitudinal stress and the maximum shear stress. | 6 |
| (c) Plot shear and bending moment diagrams for a simple beam with a uniformly distributed load. | 3+3=6 |

5. (a) Differentiate between a positive displacement machine and a rotodynamic machine. 6
- (b) Define the term “degree of reaction” in case of water turbines and classify turbine on the basis of this parameter. 2+4=6
- (c) Explain the term “slip” and “cavitation” with reference to reciprocating pump. What are the losses in a centrifugal pump? 4+4=8
6. (a) Derive the Bernoulli’s equation from Euler equation of motion, mentioning clearly the assumptions made in the derivation. What are its limitations? 6+2=8
- (b) Name five flow measuring devices and describe any two of them. 2+4=6
- (c) An open tank contains 5.0 m of oil ($\gamma=8.0\text{KN/m}^3$). Find the pressure at the bottom of the tank. 6
7. (a) Describe the physical mechanism of convection. How is the convection heat transfer co-efficient related to this mechanism? 4
- b) Derive an expression for the quantity of heat flow through a thick cylinder. 6
- (c) Draw the temperature profile for parallel flow heat exchanger, counter flow heat exchanger, boiler and condenser. 2+2=4
- (d) The glass window of a room have a total area 10m^2 and the glass is 4mm thick. Calculate the total quantity of heat that escapes from the room by conduction per second when the inside surface of windows are at 25°C and outside surface at 10°C . $k=.84\text{ W/mK}$. 6
8. (a) describe briefly the working principle of a vapor compression refrigeration system with block and p-h diagram. 10
- (b) What is Tonne of refrigeration and COP? 2+2=4
- (c) What factors are responsible for human comfort? How air conditioning is different from refrigeration? 2+4=6

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MECHANICAL ENGINEERING

Subject Code:

9	0	2
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Second Paper

Time Allowed-3 hours

Full Marks-100

[N.B.- Answer any five questions. The figures in the margin indicate full marks.]

- | | Marks |
|---|-----------------------------|
| 1. (a) What is a control chart and how it is made? State the objectives of control chart. | 3+2=5 |
| (b) Briefly describe the control chart for attributes and control chart for variables. | $2\frac{1}{2} \times 2 = 5$ |
| (c) What is acceptance sampling? Discuss different methods of acceptance sampling. | 2+8=10 |
| 2. (a) Define die casting. What are the advantages of die casting process over sand casting? | 2+3=5 |
| (b) Explain the purpose of coating on an arc welding electrode. | 5 |
| (c) What is tool signature? Sketch a single point tool bit and indicate different tool angles. | 2+4=6 |
| (d) Explain how simple indexing is done. | 4 |
| 3. (a) Differentiate among line , line & staff and functional organizations with their relative merits and demerits. | 10 |
| (b) Define personal management. What are the objectives of personal management? Describe functions of a manager in typical business organization. | 2+4+4=10 |
| 4. (a) What is Seebeck effect ? State the law of intermediate temperature of thermocouples? | 2+2=4 |
| (b) Distinguish among gauge pressure, absolute pressure and vacuum. | 4 |
| (c) Describe the operation of a Pirani thermal conductivity gauge for low pressure measurement. | 6 |
| (d) What is transducer? Describe one transducer. | 2+4=6 |
| 5. (a) Describe the physical mechanism of convection . How is convection | 4+4=8 |

heat transfer coefficient related to this mechanism?

- (b) What is Reynold's number? Distinguish between laminar and turbulent flow. 2+4=6
- (c) Explain hydrodynamic and thermal boundary layer. 6
6. (a) Explain the process and purpose of reheating steam in steam turbine application. 6
- (b) Describe the phenomenon of detonation in IC Engines .On what factor does detonation depend? 6+2=8
- (c) Discuss the working of a four stroke cycle petrol engine with the help of P-V and T-S diagram. 6
7. (a) Discuss relative merits and demerits of belt , rope and chain drive for transmission of power. 6
- (b) Describe the help of a sketch the principle of operation of an internal expanding shoe brake. 6
- (c) Differentiate between clutch and coupling. Describe with the help of a neat sketch, the working of a plate clutch. 2+6=8
8. (a) Why is balancing of rotating parts necessary for high speed engines? Explain the method of balancing of different masses revolving in the same plane. 4+6=10
- (b) What are the causes and effect of vibration? Define in short: free, force and damped vibrations. 4+(3×2)=10

28th BCS

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শব্দ চিহ্ন

বিষয় কোডঃ ৯০১

MECHANICAL ENGINEERING

First Paper

Time Allowed-3 hours

Full Marks-100

[N.B. - The figures in the margin indicate full marks. Answer any five questions.]

- | | Marks |
|---|--------|
| 1. (a) Define first law of thermodynamics and prove that heat and work are interchangeable. | 6 |
| (b) Define heat engine and heat pump. | 8 |
| (c) Explain the following:- | 6 |
| (i) Perfect gas. (ii) Combustion. (iii) Heat Exchanger. | |
| 2. (a) What is the difference between a fire tube and a water tube boiler. | 6 |
| (b) Describe with sketch the working procedure of any one of the fire tube boiler. | 8 |
| (c) Describe in short: - (i) Fusible plug. (ii) Water level indicator (iii) Super heater. | 2×3=6 |
| 3. (a) Explain the difference between a four stroke and two stroke cycle. | 6 |
| (b) Draw Otto and Diesel cycle on P-V and T-S plane and indicate different process on them. | 5+5=10 |
| (c) Distinguish between reversible and irreversible process. | 4 |
| 4. (a) What should be the properties of an ideal Refrigerant? | 8 |
| (b) Describe the factors which are to be considered for solution of Air-conditioner for an office room. | 6 |
| (c) How air conditioning is different from refrigeration? | 6 |
| 5. (a) Distinguish between forced and free convection. | 6 |
| (b) Discuss the factors due to which "Carnot Heat Engine" cycle is practicable in practice. | 10 |
| (c) What is Tonne of Refrigeration and COP? | 4 |
| 6. (a) Plot shear and bending moment diagrams for a simple beam with uniformly distributed load. | 3+3=6 |
| (b) Describe the following: - (i) Stress (ii) Hoop strain (iii) Bending moment. | 3×3=9 |
| (c) Draw stress-strain diagram for ductile and brittle material and indicate | 5 |

important point on them.

- | | |
|---|----|
| 7. (a) Define Rankine cycle. | 4 |
| (b) What is the steam turbine? | 4 |
| (c) Describe advantages of a steam turbine over steam engine. | 12 |
| 8. (a) Distinguish between an Engine and a machine. | 6 |
| (b) Explain the difference between a positive displacement machine and a rotodynamic machine. | 8 |
| (c) Name three types of Fits with sketch and places of use. | 6 |

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শঙ্খা চিল

বিষয় কোডঃ ৯০২

MECHANICAL ENGINEERING

Second Paper

Time Allowed-3 hours

Full Marks-100

[N.B.- The figures in the margin indicate full marks. Answer any five questions.]

1. Describe in short (any five):-

Marks
4×5=20

- (a) Idle wheel;
- (b) Octane Number;
- (c) C.I engine;
- (d) MIS;
- (e) Heat transfer by convection;
- (f) Moment of force;

- | | |
|--|----|
| 2. (a) What is welding? | 4 |
| (b) Name various methods of welding. | 4 |
| (c) Describe various methods of welding. | 12 |
| 3. (a) Describe relative merits and demerits of belt, rope and chain driver for Transmission of power. | 8 |
| (b) Distinguish between Spur gear, Bevel gear and Spiral gear. | 8 |
| (c) In case of power transmission explain the terms: shaft, journal and spindle. | 4 |
| 4. (a) Explain advantages of die casting over sand casting. | 6 |

- (b) Describe the different types of allowances required to give for pattern making. 8
- (c) Name the properties of sand to be used for making moulds. 6
5. (a) Explain the function of a differential gear box used on a road vehicle. 8
- (b) Write short notes on: - (i) Thermostat (ii) Air lock of diesel fuel system (iii) Engine overheating (iv) hydraulic brake. $2 \times 4 = 8$
- (c) Explain chemical reaction occur during charging of Lead Acid Battery. 4
6. (a) Describe Newton's second law of motion. 4
- (b) Describe (i) Linear velocity and linear acceleration (ii) Angular velocity and angular acceleration. $4 \times 2 = 8$
- (c) Calculate the cutting force required while turning of a work piece 300 mm dia. at 30 rpm using 6kW driver motor and assuming driving efficiency 75%. 8
7. (a) Why balancing of rotating parts is necessary for high speed engine? Explain the method of balancing of different masses revolving in the semi plane. 12
- (b) Define in short free, forced and damped vibrations. 8
8. (a) differentiate among line , line and staff and functional organizations with their relative merits and demerits. 10
- (b) What are the objectives of personal management? Describe function of a manager in a typical business organization. 10

29th BCS

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MECHANICAL ENGINEERING

First Paper

Subject Code: 901

Time Allowed-3 hours

Full Marks-100

[N.B.- Answer any five questions. The figures in the margin indicate full marks.]

- | | Marks |
|--|-------|
| 1. (a) Define second law of thermodynamics and show that no heat engine can be more efficient than a reversible heat engine working between the same temperature limits. | 10 |
| (b) What is Rankine cycle? Where it is use and why? Explain. | 10 |
| 2.(a) Illustrate the following thermodynamics processes with examples :- | 10 |
| (i) Isothermal; | |
| (ii) Adiabatic; | |
| (iii) Polytropic. | |
| (b) What is fuel? How fuel are classified? | 3 |
| (c) Define a steam boiler. Discuss the advantages of water tube boiler over fire tube boiler. | 7 |
| 3. (a) Illustrate the different processes of heat transfer and derive their heat flow equations. | 10 |
| (b) Room air is maintained at 22°C and outside air at 32°C. The room has 250mm thick brick wall consider $K_{\text{wall}}=0.70\text{W/m}^\circ\text{C}$ and $h_{\text{air}}=10\text{W/m}^2\text{C}$. Find heat flow through the wall per unit area .(Neglect the effect of radiation) | 10 |
| 4. (a) What is Refrigerant? Name different types of refrigerant. Mention important characteristics of refrigerant. | 10 |
| (b) Differentiate between window type air cooler and split type air cooler. Can an air cooler be converted into a heat pump? Is so how? | 10 |
| 6. (a) Distinguish between film wise condensation and drop wise condensation. | 5 |
| (b) Discuss briefly the bubble growth and collapse in nucleate boiling. | 8 |
| (c) Explain the working principle of a heat pipe with necessary sketch. | 7 |

7. (a) What is matrix organization? How does it differ from project organization? 10
- (b) Differentiate between training and development. Describe the different sources of recruitment in Bangladesh. 10
8. Write short notes (any five) :- 4×5=20
- (i) Condensation number;
- (ii) Regression analysis;
- (iii) Technology management;
- (iv) Jig and fixture;
- (v) Laser beam welding;
- (vi) Different types of sensing elements.

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MECHANICAL ENGINEERING

Second Paper

Subject Code: 902

Time Allowed-3 hours

Full Marks-100

[N.B.- Answer any five questions. The figures in the margin indicate full marks.]

- | | Marks |
|--|-------|
| 1. (a) Compare MIG and TIG welding process. | 8 |
| (b) List different tests which are carried out to detect defects in a weldment. Describe briefly one non-destructive NDT Test. | 12 |
| 2. (a) What factors will greatly influence the cutting tool material and geometry? | 4 |
| (b) Why it is possible to remove metal more efficiency at heavy feeds than heavy depth of cut? | 8 |
| (c) How is shear plane angle affected in cutting with variable chip thickness? | 8 |
| 3. (a) Explain permeability number in molding sand. | 5 |
| (b) Describe briefly the different steps in shell molding process. | 8 |
| (c) Discuss some of the common casing defects. | 7 |

4. (a) Discuss briefly “knocking” in SI engine. 7
- (b) What is cetane number? Explain ignition delay in an I.C engine. 8
- (c) Explain the differences between supercharging and turbocharging. 5
5. (a) What are the causes and effects of vibrations? 4
- (b) Explain why only a part of unbalanced force due to reciprocating masses is balanced by removing mass. 10
- (c) Write short notes on primary and secondary balancing. 6
5. (a) What is prancing? How it is done? 5
- (b) Water flow through a 100 mm diameter pipe. A venturimeter with a U tube manometer is connected to it to monitor its flow. The throat diameter of the venturimeter is 60 mm, the specific gravity of manometric fluid is 13.6, the coefficient of discharge is 0.32. Find the flow rate in m^3/hr for the manometric deflection of 300 mm. Deduced the equation you use. 15
6. Illustrate the following terms with necessary sketches :- $4 \times 5 = 20$
- (i) Boundary layer
 - (ii) Displacement thickness
 - (iii) Momentum thickness
 - (iv) Potential flow
 - (v) Developed flow
7. Explain the following terms :- $4 \times 5 = 20$
- (i) Principle stress
 - (ii) Shear stress
 - (iii) Bearing stress
 - (iv) Hoop stress
 - (v) Thermal stress
8. (a) Consider a cantilever beam loaded by a concentrated load at the free end together with a uniform load distributed over the half length of the beam from the fixed support. Draw the shear force and bending moment diagram. 10
- (b) Draw the head discharge and efficiency discharge curve of a centrifugal pump and show the position of maximum head and maximum efficiency. 10

30th BCS

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MECHANICAL ENGINEERING

First Paper

Subject Code: 901

Time Allowed-3 hours

Full Marks-100

[N.B.- Answer any five questions. The figures in the margin indicate full marks.]

- | | Marks |
|---|-------|
| 1. (a) How steam generators are classified? | 2 |
| (b) Discuss briefly the working of an Economiser in a Boiler Plant giving a neat sketch. | 4 |
| (c) What is meant by Boiler mountings? What are their functions? | 4 |
| (d) The following observations were made in a boiler trial: Coal used 250kg of calorific value 29,800KJ/kg, dryness fraction of steam 0.95, feed water temperature 34°C, water evaporated 2000kg and steam pressure of 11.5 bar. Calculate the equivalent evaporation “from and 100°C” per kg of coal and efficiency of the boiler. | 10 |
| 2. (a) Explain the three Laws of thermodynamics. | 9 |
| (b) What do you understand by Enthalpy? Show that for a constant pressure process, the heat supplied to the gas is equal to the change of enthalpy. | 11 |
| 3. (a) Explain the important components of a simple vapor compression refrigeration system. Also discuss the function of all components. | 10 |
| (b) Define primary and secondary refrigerant with examples. What are the properties of a good refrigerant? | 10 |
| 4.(a) Explain the following terms in connection with design of machine member subjected to variable load:- | 2×4=8 |
| (i) Endurance limit; | |
| (ii) Size factor; | |
| (iii) Surface finish factor; | |
| (iv) Notch sensitivity. | |
| (b) What is equivalent length of a column? Write the relation between length and actual length of a column for various conditions. | 2+4=6 |
| (c) Why do surfaces absorb differently for solar or earthbound radiation? | 6 |

5. (a) Distinguish between forced convection and free convection. 6
 (b) What is Tonne of refrigeration and COP? 4
 (c) Define Newton's law of Cooling. Deduce the equation of heat transfer by steady state condition through a slab. 10
6. (a) What is "fit"? Name three types of fits with their uses giving sketch. 6
 (b) What are the differences between basic size and normal size? 4
 (c) Find the thickness of the metal, necessary for a steel cylindrical shell of internal diameter 15 cm to withstand an initial pressure of 500 kg/cm^2 . The maximum hoop stress in the section is not to exceed 1500 kg/cm^2 . 10
7. (a) What is priming? 3
 (b) Explain different methods of priming. 8
 (c) Explain the following terms:- (i) Manometric head (ii) Pump Losses (iii) Pump efficiency. $3 \times 3 = 9$
8. Write short notes :- $4 \times 5 = 20$
 (a) Kirchhoff's Identity;
 (b) Rankine Cycle;
 (c) Cavitation;
 (d) Rotodynamic machine;
 (e) Zeroth law of thermodynamics.

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MECHANICAL ENGINEERING

Second Paper

Subject Code: 902

Time Allowed-3 hours

Full Marks-100

[N.B.- Answer any five questions. The figures in the margin indicate full marks.]

- | | Marks |
|--|-------|
| 1. (a) Interpret the physical significance of static balancing and dynamic balancing of a rotating mass. | 8 |
| (b) Why balancing of rotating parts is necessary for a high speed mechanics? | 6 |
| (c) Write short notes on primary and secondary balancing. | 6 |
| 2. (a) Describe the relative merits and demerits of rope , belt and chain drive for transmission of power. | 6 |
| (b) Distinguish among the spur , bevel and spiral gear. | 6 |

- (c) Illustrate briefly epicyclic gear trains with its special advantages over other gear trains. 8
3. (a) Discuss the important qualities of SI and CI engine fuel. 6
- (b) Why knocking/detonation occurs in IC engine? How to suppress it. Explain. 8
- (c) Explain why water is injected in a gas turbine? 6
4. (a) What are the functions of a condenser in a steam power plant? Why is the temperature rise of cooling water restricted? 6
- (b) What factors control the selection of particular type of nuclear reactor? 6
- (c) What do you mean by diversity factor? What are the elements which contribute the cost of electricity? 8
5. (a) What are hydrodynamic and thermal boundary layers? 6
- (b) Define the term 'boiling'. Differentiate between pool boiling and forced convection boiling. What is burnout point? 6
- (c) What is Grashoff number important in free convection heat transfer? What are the criteria to determine laminar or turbulent flow in free convection heat transfer? 8
6. (a) Differentiate between air cooling and air conditioning. 6
- (b) Explain in brief cooling with humidification process. Show this process in the psychometric chart and explain how is the same achieved in practice. 8
- (c) What are the major heat loads in an office room? 6
7. (a) What are the common sand casting defects? Discuss briefly. 6
- (b) Distinguish among the welding, soldering and brazing. 6
- (c) What is up milling and down milling? Describe their relative advantages and disadvantages. 8
8. (a) What are the various possible source of errors in measurement? What is meant by cosine error? 6
- (b) What is meant by interchangeable manufacturing? How is it different from selective assembly? 6
- (c) How quality assurance is made? What is ISO 9000 series? How to get ISO certification? 8

31th BCS

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MECHANICAL ENGINEERING

Subject Code:

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First Paper

Time Allowed-3 hours

Full Marks-100

[N.B.- Answer any five questions. The figures in the margin indicate full marks.]

1. (a) State second law of thermodynamics. What is the perpetual motion of second kind and why it is impossible? 4.5

Second law: Fundamentals of Mechanical Engineering Vol-1; chapter-1

Perpetual motion machine of second kind: A heat engine which violates the second law of thermodynamics that means heat engine which converts whole of the heat energy into mechanical work is called perpetual motion machine of second kind. It is 100% efficient machine.

Why it is impossible?

PMM2 suggests a machine which could produce work, while continuously absorbing heat from a reservoir or source.

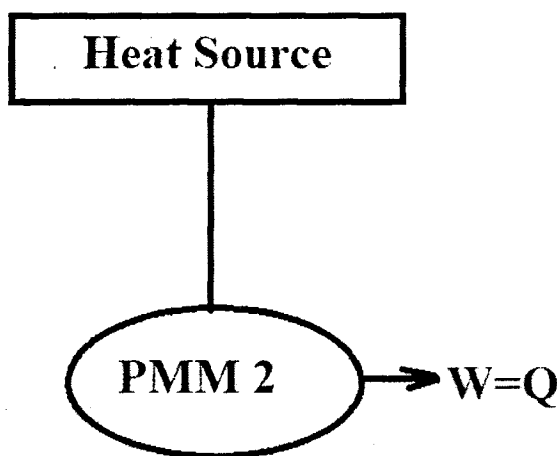


Figure: PMM-2

But PMM-2 violates the second law of thermodynamics, because second law means that heat being a low-grade energy can never be converted into work with 100% efficiency. While work being a high-grade form of energy can be completely converted into heat.

Mathematically, when work is converted into heat, we always have:

$$W = Q$$

While when heat is converted to work in a complete closed cycle process, we have:

$$Q > W$$

Therefore whenever any machine will absorb heat to produce work, it will lose/radiate some energy to the surrounding (also called a sink).

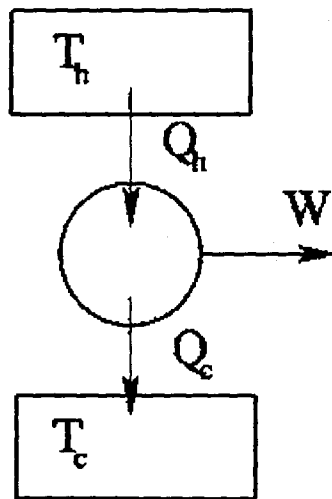


Fig: Heat engine

For example this is a heat engine. It absorbs Q_h heat from the T_h reservoir, produces work W and radiates/releases Q_c amount of heat to the sink T_c . So, PMM-2 is impossible.

(b) 0.336m^3 of gas at 10 bar and at 150°C expands adiabatically until its pressure is 4 bar. It is then compressed isothermally to its original volume. Find the final temperature and pressure of the gas.

Solution: Given: $P_1 = 10$ bar and $T_1 = 150^\circ\text{C} = 423\text{K}$; $P_2 = 4$ bar

Final temperature of gas $T_2 = ?$

We know for adiabatic process

$$\frac{P_2}{P_1} = \left(\frac{T_2}{T_1}\right)^{\frac{\gamma}{\gamma-1}}$$

$$\Rightarrow \frac{4}{10} = \left(\frac{T_2}{423}\right)^{\frac{1.4}{1.4-1}}$$

$$\therefore T_2 = 325.57 \text{ K (Answer)}$$

We know for constant volume process, $[T_2 = T_3]$

$$\frac{P_1}{T_1} = \frac{P_3}{T_3} \quad \therefore P_3 = \frac{P_1 \times T_3}{T_1} = \frac{10 \times 325.57}{423} = 7.7 \text{ bar (Answer)}$$

2. (a) Differentiate between water tube boiler and fire tube boiler.

6

Answer: Already discussed.

(b) What are the functions of a super heater and economizer in a steam generator?

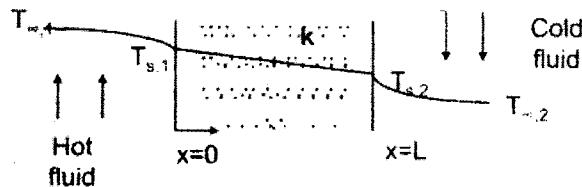
Answer: Superheater: Super heater is a device used for drying wet steam and then increasing temperature of the dry steam without increasing its pressure by utilizing the heat of combustion product.

Economizer: Economizer is a device used for heating feed water which is supplied to the boiler by utilizing heat in the exhaust flue gases before leaving through the chimney.

3. (a) Define thermal conductivity. Derive an expression for temperature distribution under one dimensional steady state heat conduction for the plane wall. 4.5

Thermal conductivity: Already discussed

Derivation:



The differential equation governing heat diffusion is: $\frac{d}{dx} \left(k \frac{dT}{dx} \right) = 0$

With constant k , the above equation may be integrated twice to obtain the general solution:

$$T(x) = C_1 x + C_2$$

Where C_1 and C_2 are constants of integration. To obtain the constants of integration, we apply the boundary conditions at $x = 0$ and $x = L$, in which case

$$T(0) = T_{s,1} \text{ and } T(L) = T_{s,2}$$

Once the constants of integration are substituted into the general equation, the temperature distribution is obtained:

$$T(x) = (T_{s,2} - T_{s,1}) \frac{x}{L} + T_{s,1}$$

The heat flow rate across the wall is given by:

$$q_x = -KA \frac{dT}{dx} = \frac{KA}{L} (T_{s,1} - T_{s,2}) = \frac{T_{s,1} - T_{s,2}}{L/KA}$$

(b) Calculate the roll of heat flow through 100 mm thick plywood wall, if the temperatures of the inside and outside surfaces are 15°C and 24°C respectively. 8

Take thermal conductivity of plywood as 23.2 w/m.k. Consider unit area.

Solution:

Given: Thickness, $x = 100\text{mm} = 0.1\text{m}$ and $T_o - T_i = 24^\circ\text{C} - 15^\circ\text{C} = 9\text{ K}$

$k = 23.2\text{ w/mK}$

We know that

$$Q = kA \frac{dT}{dx} = 23.2 \times 1 \times \frac{9}{0.1} = 2088\text{ w/m}^2 \text{ (Answer)}$$

4. (a) How does thermal radiation differs from other types of electromagnetic radiation? What is meant by radiation safe factor? 4.5

Answer: All electromagnetic radiation propagates at the speed of light. Thermal radiation is that type of electromagnetic radiation emitted by a body as a result of its temperature. Thermal radiation lies in the range from about 0.1 to $100\mu\text{m}$. The propagation of thermal radiation takes place in the form of discrete quanta. Each quantum has an energy of $E = hu$. Where h is the plank's constant. The radiation can be considered as flow of photon gas from one place to another.

Radiation shape factor: It is the fraction of radiation leaving one surface that strikes another surface directly.

(b) Why do surfaces absorb differently for solar or earth bound radiation? 8

Explain the greenhouse effect.

Answer: The radiation spectrum of the sun is concentrated in the short wavelength region. Hence the real surfaces may exhibit substantially different absorption properties for solar radiation than for long wavelength earthbound radiation.

Greenhouse effect: The greenhouse effect is the process by which radiation from a planet's atmosphere warms the planet's surface to a temperature above what it would be without this atmosphere.

Working of Greenhouse effect:

Solar energy absorbed at Earth's surface is radiated back into the atmosphere as heat. As the heat makes its way through the atmosphere and back out to space, greenhouse gases absorb much of it. Greenhouse gases are more complex than other gas molecules in the atmosphere, with a structure that can absorb heat. They radiate the heat back to the Earth's surface, to another greenhouse gas molecule, or out to space. There are several different types of greenhouse gases. The major ones are carbon dioxide, water vapor, methane, and nitrous oxide. These gas molecules all are made of three or more atoms. The atoms are held together loosely enough that they vibrate when they absorb heat. Eventually, the vibrating molecules release the radiation, which will likely be absorbed by another greenhouse gas molecule. This process keeps heat near the Earth's surface. Most of the gas in the atmosphere is nitrogen and oxygen, which cannot absorb heat and contribute to the greenhouse effect.

5. (a) Name methods of measuring liquid flow rate in (i) closed pipe and (ii) in open channel . 4.5

Methods of measuring liquid flow in closed pipe: The following is a comprehensive list of available technologies that can be used to monitor flows.

1. Velocity meter:

- i) Turbine meters
- ii) Propeller meters
- iii) Vortex meters
- iv) Magnetic flow meters
- v) Ultrasonic flow meters
- vi) Calorimetric meters

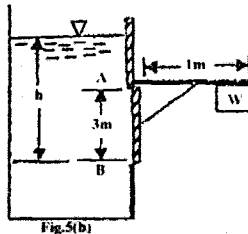
2. Differential pressure technologies:

- i) Elbow meters
- ii) Orifice plates
- iii) Flow nozzle
- iv) Venturi meters
- v) Flow tubes
- vi) Target meters
- vii) Pitot tubes

Methods of measuring liquid flow in open channel: Some of the more common methods currently in use to measure open channel flows are;

- i) Timed Gravimetric
- ii) Tracer-Dilution
- iii) Area-Velocity
- iv) Manning's Equation
- v) Hydraulic Structures (Flumes & Weirs)

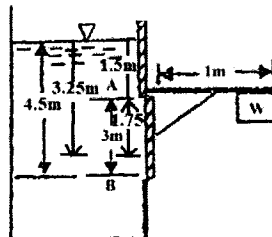
(b) A vertical gate AB shown in figure 5(b) closes a rectangular opening of size 3m × 2.5m and is pivoted at A. Find the weight W to keep the gate closed h=4.5 m.



Solution:

$$\text{Total force, } F = wA\bar{x} = 9810 \times 3 \times 2.5 \times \left(1.5 + \frac{3}{2}\right) = 220.725 \text{ kN}$$

$$\text{Centre of pressure} = \bar{x} + \frac{I_G}{A\bar{x}} = \left(1.5 + \frac{3}{2}\right) + \frac{\frac{1}{12} \times 2.5 \times 3^3}{3 \times 2.5 \times 3} = 3.25$$



$$\Sigma M_A = 0$$

$$220.725 \times 1.75 = W \times 3$$

$$\Rightarrow W = 386.3 \text{ kN (Answer)}$$

6. (a) Compare the functions of water pumps and water turbines. Mention the names of two types of pumps and two types of turbines stating their uses and limitations.

Water pumps	Water turbines
Pump converts Mechanical energy into hydraulic energy	Turbine converts hydraulic energy into Mechanical energy.
Pump adds energy to the liquid.	Turbine extract energy from the liquid
In pump, flow takes place from low pressure towards high pressure.	In turbine, flow takes place from high pressure side to low pressure side.
In pump, flow is decelerated.	In turbine, flow is accelerated.

Two types of pump:**1. Centrifugal pump**

Uses: i). Water supply & irrigation

ii). used for lifting low viscous liquid.

iii). It is used for large discharge through small head

Limitation:

i) Efficiency is low

ii) Not suitable for high head

2. Reciprocating pump:

Uses: i) It is used for lifting high viscous liquid.

ii) Pneumatic pressure system

iii) Used for high head and small discharge.

Limitation:

i) Discharge is fluctuating and pulsating

ii) High maintenance and installation cost

Two types of turbine:**1. Impulse turbine (pelton wheel):**

Uses:

i) Pelton turbine, where the water available at the high head is from 150 m to 2000 m in a hydroelectric power plant.

ii) It is also used as set up in the labs of Educational Institutions.

Limitation:

i) It requires high head for operation

ii) Turbine size is generally large

iii) Its efficiency decreases quickly with time

iv) Due to high head it is very difficult to control variations in operating head

2. Reaction turbine (Francis turbine):

Uses:

i) Large Francis turbine is individually designed for the site to operate at the highest possible efficiency, typically over 90%.

ii) In addition to electricity production and they may also be used for pumped storage; Where reservoir is filled by the turbine (acting as a pump) during low power demand, and then reversed and used to generate power during peak demand.

iii) Francis turbine may be designed for a wide range of heads and flows. This, along with their high efficiency, has made them the most widely used turbine in the world.

Limitation:

i) The water which is not dirt free can cause extremely rapid wear in a high head Francis turbine.

ii) As a spiral casing is stranded, the runner is not simply available. Therefore dismantle is hard.

iii) The repair and inspection are much harder reasonably.

iv) Cavitation is an ever-present hazard.

v) Current losses are certain.

(b) Which type of water turbine is used in Kaptai Hydroelectric and which type of pump is used in G.K project and why? 6.5

Turbine type: Kaplan

Kaplan turbines could technically work across a wide range of heads and flow rates, but because of other turbine types being more effective on higher heads, and because Kaplan's are relative expensive, they are the turbine of choice for lower head sites with high flow rates.

Pump type: Vertical turbine pump. [This information is not from a 100% reliable source]

7. (a) Name various types of stresses in a loaded beam. Explain flexure stress and shear stress. 6

Various stresses:

- i) Normal stress
- ii) Shear stress
- iii) Bending stress
- iv) Torsional stress

Flexure stress: When an object formed of a single material, like a wooden beam or a steel rod is bent, it experiences a range of stresses across its depth. At the edge of the object on the inside of the bend (concave face) the stress will be at its maximum compressive stress value. At the outside of the bend (convex face) the stress will be at its maximum tensile value. These inner and outer edges of the beam or rod are known as the 'extreme fibers'. Most materials fail under tensile stress before they fail under compressive stress, so the **maximum tensile stress** value that can be sustained before the beam or rod fails is its flexural strength. The flexural strength would be the same as the tensile strength if the material were homogeneous.

When a material is bent only the extreme fibers are at the largest stress so, if those fibers are free from defects, the flexural strength will be controlled by the strength of those **intact 'fibers'**. However, if the same material was subjected to only tensile forces then all the fibers in the material are at the same stress and failure will initiate when the weakest fiber reaches its limiting tensile stress. Therefore, it is common for flexural strengths to be higher than tensile strengths for the same material.

Shear Stress: When a body is subjected to two equal and opposite forces, acting tangentially across the resisting section, as a result of which the body tends to shear off the section, then the stress induced is called shear stress.

For example: Buy any jelly from a store. Now just take it out and put it on a plate. Now just try to flick it with your finger like how we hit the striker in carrom. This force that you are now applying near to the topmost surface of jelly is the shear force.

As jelly is semisolid, it will show some elastic deformation at the instant of application of force, but will then quickly get back to its original position. This is the shear strain (though existent for a few seconds only)

The resistance that you experience while this entire activity on your finger tip is nothing but shear stress developed.

(b) Explain torsional stress and centrifugal stress.

6.5

Torsional Stress: When a machine member is subjected to the action of two equal and opposite couples acting in parallel planes (or torque or twisting moment), then the machine member is said to be subjected to torsion. The stress set up by torsion is known as torsional shear stress. It is zero at the centroidal axis and maximum at the outer surface.

Consider a shaft fixed at one end and subjected to a torque (T) at the other end as shown in Fig. As a result of this torque, every cross-section of the shaft is subjected to torsional shear stress. We have discussed above that the torsional shear stress is zero at the centroidal axis and maximum at the outer surface. The maximum torsional shear stress at the outer surface of the shaft may be obtained from the following equation:

$$\frac{\tau}{r} = \frac{T}{J} = \frac{C \cdot \theta}{l}$$

τ = Torsional shear stress induced at the outer surface of the shaft or maximum shear stress,

r = Radius of the shaft,

T = Torque or twisting moment,

J = Second moment of area of the section about its polar axis or polar moment of inertia,

C = Modulus of rigidity for the shaft material,

l = Length of the shaft, and

θ = Angle of twist in radians on a length l

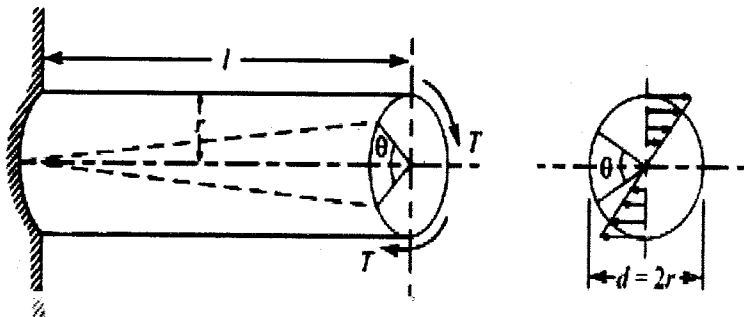


Figure: Torsional shear stress

Centrifugal stress: The stress caused by centrifugal force is called centrifugal stress.

8. (a) Discuss the relationship among load, shear stress and bending moment. 4.5

Answer:

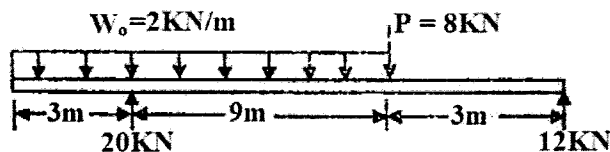
we know that

Load = $\frac{dV}{dx}$ \therefore the rate of change of the shearing force with respect to x is equal to the load or the slope of the shear diagram at a given point equals the load at that point.

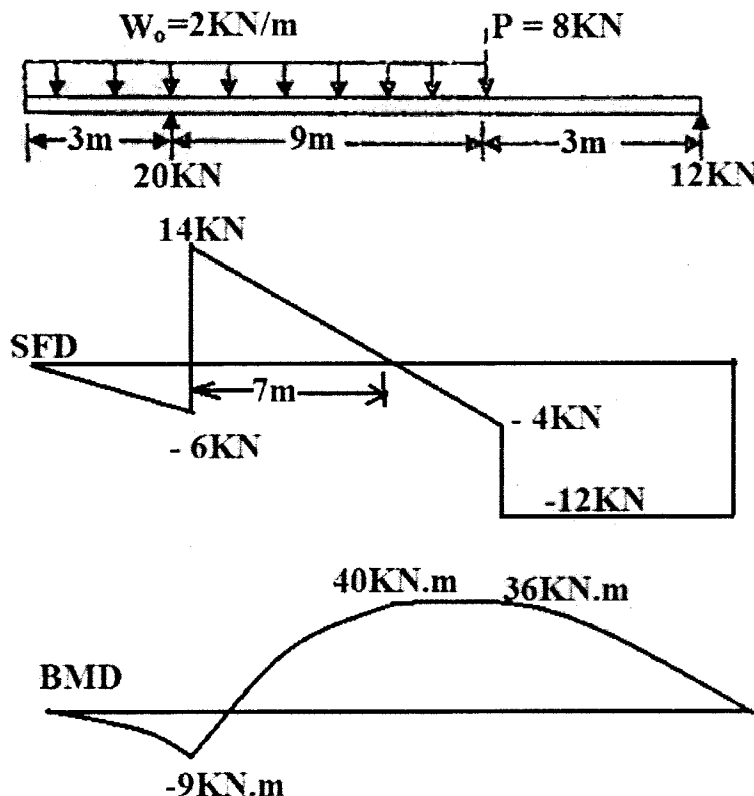
$V = \frac{dM}{dx}$ \therefore the slope of the moment diagram at a given point equals the shear force at that point.

(b) Draw the shear force and bending moment diagram for the following :

8



Answer:



9.(a) Draw the schematic diagram of a vapor compression refrigeration system. 8
State the function of each of the component show the thermodynamic process on a pressure enthalpy diagram.

Answer: Fundamentals of Mechanical engineering vol.-1, chapter-6

(b) State why capillary tube used in a domestic refrigerator instead of expansion valve.

Reasons of capillary tube use:

1. The cost of capillary tube is less than all other forms of expansion devices.
2. When the compressor stops, the refrigerant continues to flow into the evaporator and equalizes the pressure between the high pressure side and low pressure side of the system. This considerably decreases the starting load on the compressor. Thus a low starting torque motor can be used to drive the compressor, which is a great advantage.
3. Since the refrigerant charge in a capillary tube system is critical, therefore no receiver is necessary.

10. (a) Distinguish between circumferential stress the longitudinal stress in a cylindrical shell when subjected to an internal pressure.

Circumferential stress	Longitudinal stress
It acts in the tangential direction of the cylindrical shell	It acts parallel to the axis of the cylindrical shell
It is two times of longitudinal stress	It is half of circumferential stress
$\sigma_t = \frac{PD}{2t}$	$\sigma_l = \frac{PD}{4t}$

(b) 3m diameter spherical vessel is subjected to an internal pressure of of 2 N/mm². Find the thickness of the plate required if the maximum stress is not to exceed 80 N/mm²

Solution: Given;

$$D = 3\text{m and } P = 2 \text{ N/mm}^2 = 2 \times 10^6 \text{ N/m}^2$$

$$\sigma_t = 80 \text{ N/mm}^2 = 80 \times 10^6 \text{ N/m}^2$$

We know that

$$\sigma_t = \frac{PD}{2t} \quad \therefore t = \frac{PD}{2\sigma_t} = \frac{2 \times 3}{2 \times 80} = 0.0375 \text{ m (Answer)}$$

11. (a) What is fit? Discuss different types of fits.

6

Fit: Fit is defined as a degree of tightness or looseness between two mating parts to perform definite function when they are assembled together.

Different types of fits:

1. clearance Fit: In this type of fit the shaft diameter is always less than the hole diameter. For any hole and shaft assembly, if the upper limit size of the shaft is less than the lower limit size of the hole then that type of fit is known as clearance fit. Shaft can freely slide or rotate in the hole. Force is not required for this fit.

2. Transition Fit: If the maximum hole size is greater than smaller size of shaft or minimum hole size is lesser than maximum size of shaft, such type is called transition fit. This type of fit lies midway between clearance fit and interference fit and it may sometimes provide clearance fit and sometimes interference fit. For may or may not be required.

3. Interference Fit: In this type of fit the minimum diameter of the shaft is always greater than the maximum diameter of the hole. There is no relative motion between shaft and hole.

Force is required for this fit (either heating the hole or freeing the shaft).

(b) Define slenderness ratio. How it is used to define long and short column? 6.5

Slenderness ratio: It is the ratio of length of the column to the least radius of gyration.

To define long and short column:

- i) If slenderness ratio is more than 80, then column is long.
- ii) If slenderness ratio is less than 80, then column is short.

12. (a) Differentiate between:-

3×3=9

- intensive property and extensive property
- reversible process and Irreversible process
- modulus of elasticity and modulus of rigidity

Intensive property	Extensive property
Intensive properties are those that are independent of size and mass	Extensive properties are those that are dependent on size and mass of the system
Example: Temperature, pressure, age etc	Example: mass, volume, total energy etc
Cannot be computed	Can be computed
It is used to determine the identity of the system	Cannot be used to define the identity of the system

Reversible process	Irreversible process
The process is carried out infinitesimally slowly	It is carried out rapidly
At any stage, the equilibrium is not disturbed	Equilibrium may exist only after the completion of the process
It takes infinite time for completion	It takes finite time for completion
Work obtained in this process is maximum	Work obtained in this process is not maximum

Modulus of elasticity	Modulus of rigidity
Forces which are normal to the surface	Forces acting the surface parallel laterally to it
The deformation is linear	The deformation is a circular one
Effective only for elastic deformations	Effective for both non-elastic and elastic deformations
The object in the deforming force either gets shortened or lengthened	One of the exteriors of the object becomes displaced concerning another surface
Larger than the modulus of rigidity	Smaller than the modulus of elasticity

(b) What is stagnation pressure and how it is measured in a flow field? 3.5

Stagnation pressure: In fluid dynamics, stagnation pressure (or pitot pressure) is the static pressure at a stagnation point in a fluid flow. At a stagnation point the fluid velocity is zero. In an incompressible flow, stagnation pressure is equal to the sum of the free-stream static

pressure and the free-stream dynamic pressure.

Measurement: The magnitude of stagnation pressure can be derived from Bernoulli's equation. For incompressible flow and no height changes. For any two points 1 and 2:

$$P_1 + \frac{1}{2} \rho V_1^2 = P_2 + \frac{1}{2} \rho V_2^2$$

$$P_{\text{static}} + \frac{1}{2} \rho V^2 = P_{\text{stagnation}} + \frac{1}{2} \rho 0^2$$

$$P_{\text{stagnation}} = P_{\text{static}} + \frac{1}{2} \rho V^2$$

31th BCS

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MECHANICAL ENGINEERING

Subject Code:

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Second Paper

Time Allowed-3 hours

Full Marks-100

[N.B.- Answer any five questions. The figures in the margin indicate full marks.]

1. (a) What are various types of gear train? Briefly explain an epicyclic gear train 6 but mentioning its use and advantages.

Answer: Various types of gear train are:

1. Simple gear train
2. Compound gear train
3. Reverted gear train
4. Epicyclic gear train

Epicyclic gear train: A simple epicyclic gear train shown in the figure where a gear A and the arm C have a common axis at point O_1 about which they can rotate. The gear B meshes with gear A and has its axis on the arm at point O_2 , about which the gear B can rotate. If the arm is fixed, the gear train is simple and gear A can drive gear B or vice-versa, but if gear A is fixed and the arm is rotated about the axis of gear A then the gear B is forced to rotate upon and around gear A. such a motion is called epicyclic and the gear trains arranged in such a manner that one or more of their members move upon and around another member are known as epicyclic gear trains. The epicyclic gear trains may be simple or compound.

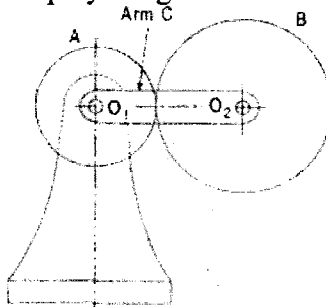


Fig: Epicyclic gear train

(b) Derive the condition for transmitting the maximum power in a flat belt drive. 6.5

Why balancing of rotating parts of engine is necessary?

Condition for transmitting maximum power:

We know that power transmitted by a belt, $P = (T_1 - T_2)v$

Where, T_1 = Tension in the tight side of the belt in newtons

T_2 = Tension in the slack side of the belt in newtons

v = velocity of the belt in m/s

We know, $\frac{T_1}{T_2} = e^{\mu\theta}$ or $T_2 = \frac{T_1}{e^{\mu\theta}}$

Now, $P = \left(T_1 - \frac{T_1}{e^{\mu\theta}}\right)v = T_1 \left(1 - \frac{1}{e^{\mu\theta}}\right)v = T_1 \times C \times v$

Where, $C = \left(1 - \frac{1}{e^{\mu\theta}}\right)$

We know that, $T_1 = T - T_c$

Where, T = maximum tension to which the belt can be subjected in newtons and

T_c = centrifugal tension in newtons

Substituting the value of T_1 , we get $P = (T - T_c)vC$

$$= (T - m \cdot v^2)v \cdot C$$

$$= (T \cdot v - m \cdot v^3)C$$

For maximum power, differentiate the above expression with respect to v and equate to zero, i.e.

$$\frac{dP}{dv} = 0 \text{ or } \frac{d}{dv} = (T \cdot v - m \cdot v^3)C$$

$$\therefore T - 3mv^2 = 0 \text{ or } T - 3T_c = 0 \text{ or } T = 3T_c$$

It shows that when the power transmitted is maximum, $\frac{1}{3}^{\text{rd}}$ of the maximum tension is absorbed as centrifugal tension.

Necessity of Balancing: Balancing of rotating parts is important. Unbalanced mass create shaking force and shaking couple on rotating parts. Undesirable vibration and sound generate. Also stress developed in the rotating parts. So, balancing is essential.

2.(a) Why balancing of the rotating parts of engine is necessary? 3

Answer: Necessity of Balancing: Balancing of rotating parts is important. Unbalanced mass create shaking force and shaking couple on rotating parts. Undesirable vibration and sound generate. Also stress developed in the rotating parts. So, balancing is essential.

(b) What do you understand by static balance and dynamic balance? 4

Answer:

Static balance: Static balance is the ability to maintain postural stability and orientation with center of mass over the base of support and body at rest.

Dynamic balance: Dynamic balance is the ability to maintain postural stability and orientation with center of mass over the base of support while the body parts are in motion.

(c) Deduce an expression for the natural frequency of free transverse Vibration by equilibrium method. 5.5

Answer:

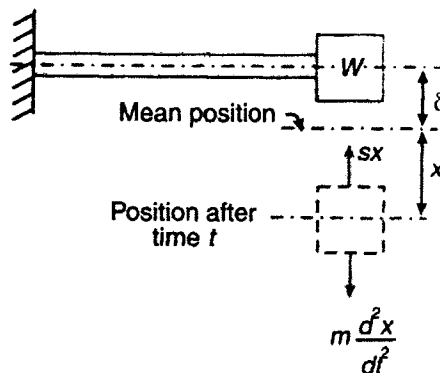


Fig. Natural frequency of free transverse vibrations.

Where,

- s = Stiffness of shaft
- δ = Static deflection due to the weight of the body
- x = Displacement of the body from the mean position after time t
- m = Mass of body = W/g (Shaft mass is neglected in this case)

Now, let's see the body is in the equilibrium position, the gravitational pull given by

$$W = m \times g$$

This gravitational pull will be balanced by the shaft stiffness. so that we can write

$$W = s \times \delta$$

Let's give a displacement to the mass m by a distance x from its equilibrium position.

The restoring force will be

$$\begin{aligned} W - s(\delta + x) \\ = W - s\delta - sx \\ = -s \times x; (W = s \times \delta) \end{aligned}$$

Taking upward force as negative

and accelerating force will be the Mass \times Acceleration

$$= m \times \frac{d^2x}{dt^2}$$

taking downward force as positive

From the above two equations of motion of the body of mass m after time t is given by

$$\begin{aligned} m \times \frac{d^2x}{dt^2} &= -s \times x \\ \Rightarrow m \times \frac{d^2x}{dt^2} + s \times x &= 0 \\ \Rightarrow \frac{d^2x}{dt^2} + \frac{s}{m} \times x &= 0 \end{aligned}$$

From the fundamental equation of the simple harmonic motion of the body is

$$\frac{d^2x}{dt^2} + \omega^2 x = 0$$

So equating these two similar equations will get us

$$\omega = \sqrt{\frac{s}{m}}$$

∴ Time period

$$t_p = \frac{2\pi}{\omega} = 2\pi \sqrt{\frac{m}{s}}$$

The natural frequency

$$f_n = \frac{1}{t_p} = \frac{1}{2\pi} \sqrt{\frac{s}{m}} = \frac{1}{2\pi} \sqrt{\frac{g}{\delta}} \quad (\text{Answer})$$

3.(a) Classify internal combustion engine according to valve location.

2.5

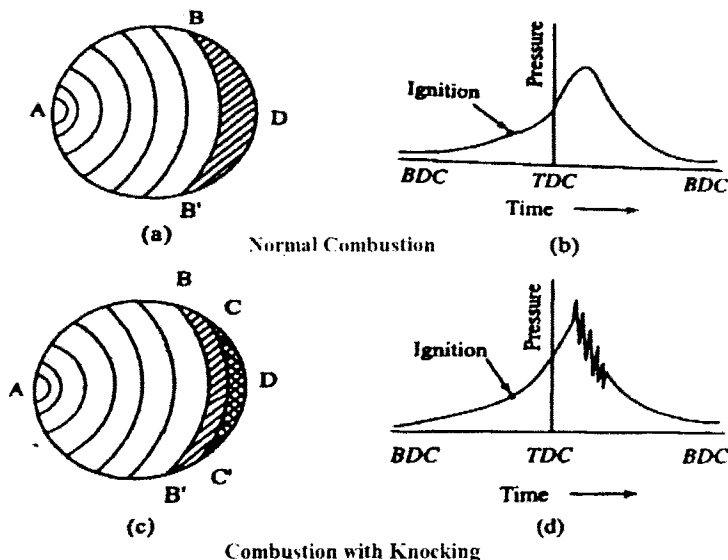
Answer:

1. In line
2. V shape
3. Radial
4. Opposed cylinder
5. Opposed piston

(b) Explain the knocking mechanism of spark ignition engine.

4

Answer: Knocking in spark ignition internal combustion engines occurs when combustion of some of the air/fuel mixture in the cylinder does not result from propagation of the flame front ignited by the spark plug, but one or more pockets of air/fuel mixture explode outside the envelope of the normal combustion front. The fuel-air charge is meant to be ignited by the spark plug only, and at a precise point in the piston's stroke. Knock occurs when the peak of the combustion process no longer occurs at the optimum moment for the four stroke cycle. The shock wave creates the characteristic metallic "pinging" sound, and cylinder pressure increases dramatically. Effects of engine knocking range from inconsequential to completely destructive.



(c) What are the factors to be considered in the design of combustion Chamber of CI engine? Explain them. 6

Answer:

1. High thermal efficiency.
2. Ability to use less expensive fuel (multi-fuel).
3. Ease of starting.
4. Ability to handle variations in speed.
5. Smoothness of operation i.e. avoidance of diesel knock and noise.
6. Low exhaust emission.
7. Nozzle design.
8. High volumetric efficiency.
9. High brake Mean effective pressure.

4. (a) Why cooling towers are used in steam power plants? Compare forced draft cooling tower with and induced draft cooling tower. 4.5

Answer:

Use of cooling tower: A cooling tower is a heat rejection device, which extracts waste heat to the atmosphere through the cooling of a water stream to a lower temperature. The type of heat rejection in a cooling tower is termed "evaporative" in that it allows a small portion of the water being cooled to evaporate into a moving air stream to provide significant cooling to the rest of that water stream. The heat from the water stream transferred to the air stream raises the air's temperature.

(b) the daily load of power station is given below: --

8

Time	12 Night	2AM	6AM	8AM	12 Noon	1PM	5PM	6PM	12 Night
Load (MW)	20	10	16	50	50	60	50	70	20

(i) Plot the load curve and find the load factor.

(ii) What is the use factor of this plant serving this load if its capacity is 100 MW?

Answer: Same as Question-1, North West Power Generation Company Limited (NWPGL)

5.(a) What is natural convection? What are the application of natural convection? 3

Answer: Natural convection: Natural convection, known also as free convection is a mechanism, or type of mass and heat transport, in which the fluid motion is generated only by density differences in the fluid occurring due to temperature gradients, not by any external source (like a pump, fan, suction device, etc.).

Applications of natural convection: Heat transfer by natural convection inside the tube (circular or square) has a large number of applications in industries. These include solar water heating systems; cooling of gas turbine blades, heat exchangers etc.

(b) What is Grashof number? Why it is important in natural convection? Why 4.5

heat transfer coefficient is higher in forced convection?

Answer:

Grashof number: The Grashof number (Gr) is a dimensionless number in fluid dynamics and heat transfer which approximates the ratio of the buoyancy to viscous force acting on a fluid.

Grashof number in convection: Grashof's number represents how dominant is the buoyancy force which is responsible for the convection comparing to the viscous forces.

Heat transfer coefficient is higher in forced convection: The convection heat transfer coefficient will usually be higher in forced convection since heat transfer coefficient depends on the fluid velocity, and forced convection involves higher fluid velocities.

(c) Why is boundary layer formed sketch the different boundary layer regimes on a flat plate.

Answer:

Boundary layer: A boundary layer is the layer of fluid in the immediate vicinity of a bounding surface where the effects of viscosity are significant. Boundary layer formed for the adhesive force between the moving fluid and a solid surface.

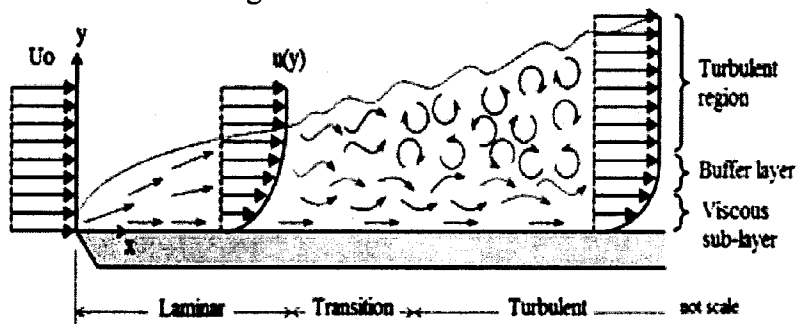


Fig: Different boundary layer region on plate

6.(a) Define the cooling load in designing and air conditioning system. What are the components of cooling load in Air Conditioning system? Explain the form room sensible heat factor.

Answer: Cooling load: Cooling load is the rate at which sensible and latent heat must be removed from the space to maintain a constant space dry-bulb air temperature and humidity.

Components of cooling load: The cooling load for the AC generally consists of four parts, that is, the transmission load, infiltration load, solar load and internal load.

Room sensible heat factor: Room Sensible Heat Factor - RSHF - is defined as sensible heat load divided by total heat load in a room.

The Room Sensible Heat Factor - RSHF - expresses the ratio between sensible heat load and total heat load in a room. It can be expressed as:

$$RSHF = \frac{Q_{sr}}{Q_{tr}}$$

Where, RSHF = room sensible heat factor

Q_{sr} = sensible heat load in room (kW, Btu/hr)

Q_{tr} = total heat load in room (kW, Btu/hr)

(b) Discuss with figure the different types of duct system in Air Conditioning system.

6

Answer:

1. Flexible ductwork: This type of duct is made of a metal wire coil and is covered with a layer of flexible plastic. The flexible air duct also has thermal insulation made of glass wool, though other materials like polyethylene or metalized PET.
2. Rigid ductwork: Rigid ductwork comes in a variety of shapes, size and materials. A rigid duct can be customized according to customer needs. They are hard, reliable, safe and enduring.
3. Sheet metal ducts: Usually, Galvanized steel and aluminum are used in the making of this type of ductwork, but aluminum is preferred because of its lightweight and ease in installing.
4. Fiberboard ducts: Fiberboard is compressed and resin-bonded fiberglass which is then laminated with a foil sheet. This lamination protects them for moisture. A fiberboard air duct is mostly preferred for heating and cooling systems because it is insulated. But just like fiberglass lined air ducts, these air ducts are not recommended for ventilation as they too can become a home to mold and bacteria.

7. (a) Define welding. Distinguish among soldering brazing and braze welding.

4

Welding: Welding is a process of joining two similar or dissimilar metals by fusion, with or without the application of pressure and with or without the use of filler metal.

Soldering: Soldering is a joining process used to join different types of metals together by melting solder. Solder is a metal alloy usually made of tin and leads which is melted using a hot iron.

Brazing: Brazing is a metal-joining process in which two or more metal items are joined together by melting and flowing a filler metal into the joint, with the filler metal having a lower melting point than the adjoining metal.

(b) How can you specify a lathe machine?

3

Answer:

1. Distance between live center and dead center
2. Swing over the bed
3. Swing over the cross slide
4. Bed length

(c) What is tool life? Derive an expression of economical tool life.

5.5

Answer:

Tool life: Tool life is the duration of actual cutting time after which the tool is no longer usable.

A tool life equation was developed by Taylor, and is outlined below,

$$V \times T^n = C$$

Where, V= cutting velocity in ft./min

T=tool life in minutes

n= a constant based on the tool material

C= a constant based on the tool and work

8. (a) Discuss the common error in measurement.

4

Answer:

Common errors in measurement are:

1. Instrumental: For example, a poorly calibrated instrument such as a thermometer that reads 102°C when immersed in boiling water and 2°C when immersed in ice water at atmospheric pressure. Such a thermometer would result in measured values that are consistently too high.
2. Observational: For example, parallax in reading a meter scale.
3. Environmental: For example, an electrical power brown out that causes measured currents to be consistently too low.
4. Theoretical: Due to simplification of the model system or approximations in the equations describing it. For example, if your theory says that the temperature of the surrounding will not affect the readings taken when it actually does, then this factor will introduce a source of error.

(b) Explain briefly the working principle of

4

(i) dynamometer**(ii) strain gauge**

Answer: Dynamometer: A dynamometer is a device for simultaneously measuring the torque and rotational speed (RPM) of an engine, motor or other rotating prime mover so that its instantaneous power may be calculated, and usually displayed by the dynamometer itself as kW or bhp.

Strain gauge: A strain gauge (also spelled strain gage) is a device used to measure strain on an object. A strain gauge takes advantage of the physical property of electrical conductance and its dependence on the conductor's geometry. When an electrical conductor is stretched within the limits of its elasticity such that it does not break or permanently deform, it will become narrower and longer, which increases its electrical resistance end-to-end. Conversely, when a conductor is compressed such that it does not buckle, it will broaden and shorten, which decreases its electrical resistance end-to-end. From the measured electrical resistance of the strain gauge, the amount of induced stress may be inferred.

(c) Discuss briefly the concept of Total Quality Management and total quality control.

4.5

Answer:

Total quality management: TQM is a continuous process of increasing the quality of the output by eliminating waste and the non-value adding activities in the system. In organizational perspective, a quality product comes within a quality process, which means that quality should be built into the process. TQM consists of organization-wide efforts to install and make permanent; a climate in which an organization continuously improves its ability to deliver high- quality products and services to customers.

Total quality control: Total Quality control, or TQC for short, is a process by which entities review the quality of all factors involved in production. TQC is concerned with ensuring that a product meets the prescribed technical standard of quality, and meets the customer's requirements. It involves physical checking of activities at each specified stage of production

from receiving materials and manufacturing to testing, packing and shipping. It provides a control over the entire production process.

9.(a) Compare the function of “personnel manager” and those of “general manager (CEO)”. **4.5**

Answer: Functions of Personnel Manager

- Counsellor
- Initiating Policies
- The Advisory Role
- The Link between the Employees and the Management
- Representative Role
- Decision-making Role
- Mediator Role
- Leadership Role
- Welfare Role
- Research Role

Functions of general manager:

- A general manager is expected to improve efficiency and increase profits while managing the overall operations of a company or division.
- General manager duties include managing staff, overseeing the budget, employing marketing strategies, and many other facets of the business.
- General managers often report to higher-level managers or executives and supervise lower-level managers.
- General managers hold various titles, such as CEO, branch manager, or operations manager.

(b) What is a “Matrix Organization” Discuss it briefly by mentioning examples, advantages and disadvantages. What is SBU (Strategic Business Unit)? **8**

Answer:

Matrix Organization: A matrix organization is defined as one in which there is dual or multiple managerial accountability and responsibility. However, the term matrix means quite different things to different people and in different industries. In a matrix there are usually two chains of command, one along functional line and the other along project, product, or client lines. Other chains of command such as geographic location are also possible.

Advantages of matrix organizational structures

There are several benefits of implementing a matrix organizational structure within the workplace. These benefits include:

1. Increased communication efficiency
2. Improved employee motivation
3. Increased teamwork
4. Maximizes resource usage
5. Increased employee professional development

Disadvantages of matrix organizational structures

While there are many benefits to this type of workplace structure, there are also a few disadvantages to consider. These include:

1. Potential conflict between managers and projects
2. Authority confusion
3. Reduced employee effectiveness
4. Increased management overhead costs

10.(a) What are various method of technology transfer? Explain briefly-

4

(i) Turnkey project (ii) Reverse engineering

Answer:

Methods of technology transfer:

- Licensing
- Support Contract
- Joint Venture
- Franchising
- Strategic Alliance
- Turnkey Agreement
- Equipment Acquisition
- Management Contract

Trunkey project: A turnkey project is a type of project that is constructed so that it can be sold to any buyer as a completed product. This is contrasted with build to order, where the constructor builds an item to the buyer's exact specifications, or when an incomplete product is sold with the assumption that the buyer would complete it.

Reverse engineering: Reverse engineering (also known as backwards engineering or back engineering) is a process or method through the application of which one attempts to understand through deductive reasoning how a device, process, system, or piece of software accomplishes a task with very little (if any) insight into exactly how it does so.

(b) Discuss Technology life cycle in briefly. Take any related examples to discuss.

4.5

Answer:

Technology life cycle: The technology life-cycle (TLC) describes the commercial gain of a product through the expense of research and development phase, and the financial return during its "vital life". Some technologies, such as steel, paper or cement manufacturing, have a long lifespan (with minor variations in technology incorporated with time) while in other cases, such as electronic or pharmaceutical products, the lifespan may be quite short.

Example - Technology Life Cycle in cars

On March 8, 1866 Daimler designed world's first four-wheeled automobile. Later, Henry Ford made his first car in 1896 called Quandricycle and later on introduced model T, which became a success after installing assembly lines in 1913. Many technological changes have taken place at very fast pace in cars during last 140-150 years.

Fuels used	Types of Engine	Body
Steam	From 2 stroke engine to 4	Sharp Edges to round &

Coal gas Gunpowder Mixture of Hydrogen & Oxygen Kerosene Petrol / Diesel Electricity Future aim: Solar	stroke Manual steering to Power steering Continuous Improvement in features based on electronics Car which can run on road and fly	smooth surfaces with aerodynamics From metallic interiors to plastic based interiors
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(c) Differentiate HRM (Human Resource Management) from personnel management.

4

Answer:

Basis for comparison	Personnel management	Human resource management
Meaning	The aspect of management that is concerned with the work force and their relationship with the entity is known as Personnel Management.	The branch of management that focuses on the most effective use of the manpower of an entity, to achieve the organizational goals is known as Human Resource Management.
Approach	Traditional	Modern
Treatment of manpower	Machines or Tools	Asset
Type of function	Routine function	Strategic function
Basis of Pay	Job Evaluation	Performance Evaluation
Management Role	Transactional	Transformational
Communication	Indirect	Direct
Labor Management	Collective Bargaining Contracts	Individual Contracts
Initiatives	Piecemeal	Integrated
Management Actions	Procedure	Business needs
Decision Making	Slow	Fast
Job Design	Division of Labor	Groups/Teams
Focus	Primarily on mundane activities like employee hiring, remunerating, training, and harmony.	Treat manpower of the organization as valued assets, to be valued, used and preserved.

11.(a) What is casting? Discuss basic features in all casting process.

5.5

Answer:

Casting: Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify.

Processes of casting:

Basic features in all casting:

- Base feature
- Local feature
- Tooling feature

Connecting feature and modifier

(b) What are the common castings defects discuss briefly?

7

Answer: Common casting defects are:

1. Gas Porosity
 - a. Pinholes
 - b. Blowholes
 - c. Open Holes
2. Shrinkage Defects
 - a. Open
 - b. Closed
 - c. Warping
3. Mold Material Defects
 - a. Cuts and Washes
 - b. Swells
 - c. Drops
 - d. Metal Penetration
 - e. Rat Tails
 - f. Fusion
 - g. Run Out
4. Pouring Metal Defects
 - a. Cold Shot
 - b. Cold Shut
 - c. Misrun
5. Metallurgical Defects
 - a. Hot Tears
 - b. Hot Spots
 - c. Slag inclusion
6. Casting Shape Defects
 - a. Mismatches
 - b. Flash

12. (a) In how many ways you can make a spur gear? Name the process only.

6.5

Discuss briefly the gear cutting procedures by milling machine.

Answer: Ways of spur gear making:

- Machining
- Casting
- Stamping
- Coining

- Cold drawing
- Rolling
- Extrusion
- Powder metallurgy
- Plastic molding

Gear cutting procedure in milling machine:

The formed milling operations are usually employed for cutting spur gear, but these can be employed for cutting every type of gear by using a universal indexing mechanism. The cutter is mounted on the spindle in both horizontal and vertical milling machines and rotates while the work is mounted on the table and reciprocated under the cutter. Once the cutter finishes tooth profile, the work is indexed to the next position, and again the tooth profile is finished and so on.

Gear milling process is employed for coarse pitch gears, racks of all pitches, segment gears, worms and toothed parts as sprockets, and ratchets.

(b) Discuss briefly the testing procedure for welded joint.

6

Answer:

There are two types of method for welding joint.

(i) Destructive testing:

Tensile Test

Bend Test

Hardness Test

Toughness Testing

Fatigue Test

(ii) Non-destructive testing

Detection of surface flaws

Visual

Magnetic Particle Inspection

Fluorescent Dye Penetrant Inspection

Detection of internal flaws

Radiography

Ultrasonic Testing

Eddy current Testing

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MECHANICAL ENGINEERING**Subject Code:**

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First Paper**Time Allowed-3 hours****Full Marks-100****[N.B.- Answer any five questions. The figures in the margin indicate full marks.]**

1.(a) What are the impurities content in Cast Iron and what are their effects on cast iron. 6.5

Answer: Impurities Content:

- i) Silicon
- ii) Sulphur
- iii) Manganese
- iv) Phosphorous

Effect on cast iron: Silicon: It may be present in cast iron upto 4%. It provides the formation of free graphite which makes the iron soft and easily machinable. It also produces sound castings free from blow-holes, because of its high affinity for oxygen.

Sulphur: It makes the cast iron hard and brittle. Since too much sulphur gives unsound casting, therefore, it should be kept well below 0.1% for most foundry purposes.

Manganese: It makes the cast iron white and hard. It is often kept below 0.75%. It helps to exert a controlling influence over the harmful effect of sulphur.

Phosphorus: It aids fusibility and fluidity in cast iron, but induces brittleness. It is rarely allowed to exceed 1%. Phosphoric irons are useful for casting of intricate design and for many light engineering castings when cheapness is essential.

(b) What are the defects in casting a metal? 6

Defects: There are some defects in casting a metal given below;

1. Gas porosity: Gas porosity is the formation of bubbles within the casting after it has cooled. This occurs because most liquid materials can hold a large amount of dissolved gas, but the solid form of the same material cannot, so the gas forms bubbles within the material as it cools. Gas porosity may present itself on the surface of the casting as porosity or the pore may be trapped inside the metal, which reduces strength in that vicinity. Nitrogen, oxygen and hydrogen are the most encountered gases in cases of gas porosity. In aluminium castings, hydrogen is the only gas that dissolves in significant quantity, which can result in hydrogen gas porosity.

2. Shrinkage defects: Shrinkage defects can occur when standard feed metal is not available to compensate for shrinkage as the thick metal solidifies. Shrinkage defects will have jagged or linear appearance. Shrinkage defects usually occur in either the cope or drag portion of the casting. Shrinkage defects can be split into two different types: **open shrinkage defects and closed shrinkage defects.**

Open shrinkage defects are open to the atmosphere, therefore as the shrinkage cavity forms, air compensates. There are two types of open air defects: pipes and caved surfaces. Pipes form at the surface of the casting and burrow into the casting, while caved surfaces are shallow cavities that form across the surface of the casting.

Closed shrinkage defects, also known as shrinkage porosity, are defects that form within the casting. Isolated pools of liquid form inside solidified metal, which are called hot spots. The shrinkage defect usually forms at the top of the hot spots. They require a nucleation point, so impurities and dissolved gas can induce closed shrinkage defects. The defects are broken up into microporosity and microporosity (or micro shrinkage), where microporosity can be seen by the naked eye and microporosity cannot.

3. Pouring metal defects: Pouring metal defects include misruns, cold shuts and inclusions. A misrun occurs when the liquid metal does not completely fill the mould cavity, leaving an unfilled portion. Cold shuts occur when two fronts of liquid metal do not fuse properly in the mould cavity, leaving a weak spot. Both are caused by either a lack of fluidity in the molten metal or cross-sections that are too narrow. The fluidity can be increased by changing the chemical composition of the metal or by increasing the pouring temperature. Another possible cause is back pressure from improperly vented mould cavities. An inclusion is a metal contamination of dross, if solid, or slag, if liquid. These usually are impurities in the pour metal (generally oxide, less frequently nitride, carbide, or sulfides), material that is eroded from furnace or ladle linings, or contaminates from the mould. In the specific case of aluminium alloys, it is important to control the concentration of inclusions by measuring them in the liquid aluminum and taking actions to keep them to the required level.

4. Metallurgical defects: There are two defects in this category: **hot tears** and **hot spots**. Hot tears, also known as hot cracking, are failures in the casting that occur as the casting cools. This happens because the metal is weak when it is hot and the residual stresses in the material can cause the casting to fail as it cools. Proper mould design prevents this type of defect.

Hot spots are sections of casting which have cooled down more slowly than the surrounding material due to higher volume than its surrounding. This causes abnormal shrinkage in this region, which can lead to porosity and cracks. This type of defect can be avoided by proper cooling practices or by changing the chemical composition of the metal.

2.(a) Discuss the mechanical properties of metal which are associated with the ability of the material to resist mechanical forces. 6

Answer: Fundamentals of Mechanical Engineering vol.-1, chapter-10.

(b) Define and discuss in brief the various heat treatment process (at least 3), commonly employed in engineering practice. 6.5

Answer: Fundamentals of Mechanical Engineering vol.-1, chapter-10.

3.(a) What is Cavitation? Write the demerits of cavitation in hydraulic machine. 6

Answer: Fundamental of Mechanical Engineering vol-1, chapter-3.

(b) A pelton wheel develops 1750 KW under a head of 100 m while running at 200 RPM and discharging 2500 liters of water per second. What is the unit power of the wheel? 6.5

Solution:

Given;

Power developed, $P = 1750 \text{ KW}$

Head, $H = 100 \text{ m}$

$N = 200 \text{ rpm}$

$Q = 2500 \text{ L/s} = 2.5 \text{ m}^3/\text{s}$

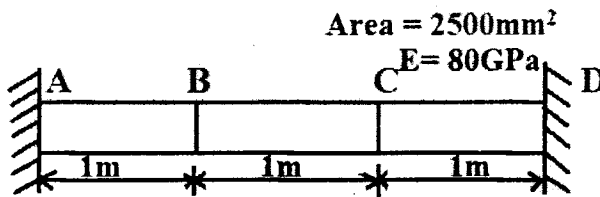
We know,

$$\text{Unit Power, } P_u = \frac{P}{H^{3/2}} = \frac{1750}{100^{3/2}} = 1.75 \text{ KW (Answer)}$$

4.(a) Draw stress strain curve for mild steel and label its different points. 4

Answer: Fundamentals of Mechanical Engineering Vol.-1, chapter-7.

(b) An aluminum bar is loaded as shown in the following figure. Find the deformation at section B and C:- 8.5



Solution:

Reaction at A and D for load 200 KN;

$$R_{A1} = \frac{200 \times 2}{3} = 133.33 \text{ KN} \quad \text{and} \quad R_{D1} = \frac{200 \times 1}{3} = 66.67 \text{ KN}$$

Reaction at A and D for load 150 KN;

$$R_{A2} = \frac{150 \times 1}{3} = 50 \text{ KN} \quad \text{and} \quad R_{D2} = \frac{150 \times 2}{3} = 100 \text{ KN}$$

Total reaction at A and D, $R_A = 183.33 \text{ KN}$ and $R_D = 166.67 \text{ KN}$

Resultant force at section B and C, $P_{BC} = 200 - 183.33 = 16.67 \text{ KN} = 16670 \text{ N}$

$$\therefore \text{Deformation at section B and C, } \delta = \frac{P_{BC} \times L_{BC}}{A \times E} = \frac{16670 \times 1}{2500 \times 10^{-6} \times 80 \times 10^9} = 8.335 \times 10^{-5} \text{ m}$$

(Answer)

5. (a) Define principal stress and prove that at the plane of principal stress shear stress is zero. 4

Principal Stress: The normal stresses, acting on a principal plane are known as principal stresses.

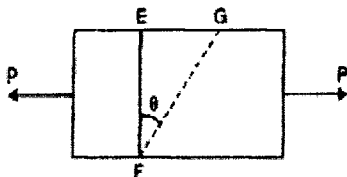
Proof:

Figure: 1

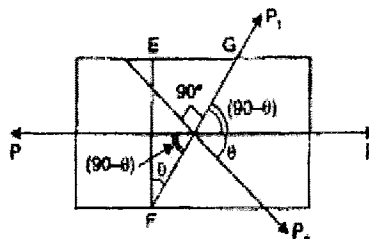


Figure: 2

Figure 1 shows a rectangular member of uniform cross-sectional area A and of unit thickness.

Let, P = Axial force acting on the member

A = Cross-sectional area, which is perpendicular to the line of axis of the force P .

The stress along x-axis, $\sigma = \frac{P}{A}$

Hence, the member is subjected to a stress along x-axis

Consider a cross-section EF which perpendicular to the line of action of the force P .

Then, area of section $EF = EF \times 1 = A$ [unit thickness]

The stress on the section EF is given by

$$\sigma = \frac{P}{A}$$

The stress on the section EF is entirely normal stress. There is no shear (tangential) stress on the section EF . So the section EF is principal plane.

Now consider a section FG at an angle θ with the normal cross-section EF as shown in figure 2.

Area of section $FG = FG \times 1$ (member is having unit thickness)

$$= \frac{EF}{\cos \theta} \times 1$$

$$= \frac{A}{\cos \theta}$$

\therefore Stress on the section, FG

$$= \frac{P}{\frac{A}{\cos \theta}}$$

$$= \sigma \cos \theta$$

This stress may be resolved in two components, one is normal components and another is tangential (shear) components.

The normal stress and shear stress on the section FG are obtained as given below;

Let, P_n = force normal to section $FG = p \cos \theta$

P_t = Tangential force = $p \sin \theta$

σ_n = Normal stress

σ_t = Shear (tangential) stress

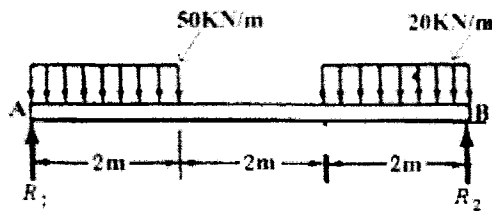
$$\text{Normal stress } \sigma_n = \frac{p \cos \theta}{\frac{A}{\cos \theta}} = \sigma (\cos \theta)^2$$

Tangential or shear stress $\sigma_t = \frac{p \sin \theta}{\frac{A}{\cos \theta}} = \sigma \sin \theta \cos \theta = \frac{\sigma}{2} \sin 2\theta$

Now, if $\theta = 0$ then FG plane coincide with EF plane and shear stress becomes Zero. So the plane becomes principal plane. So the plane has principal stress only.

So the plane of principal stress shear stress is zero.

(b) For the beam as shown in the following figure draw the shear and moment diagram:- 8.5



Solution:

$$\Sigma M_{R_1} = 0$$

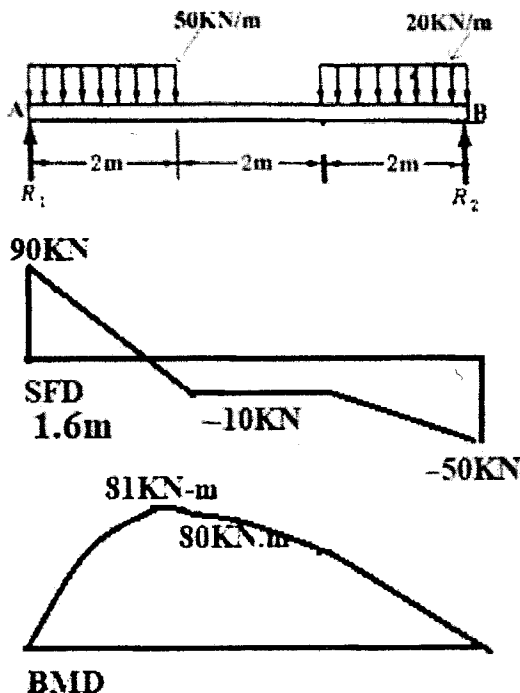
$$6R_2 = (40 \times 5) + (100 \times 1)$$

$$\therefore R_2 = 50 \text{ KN}$$

$$\Sigma M_{R_2} = 0$$

$$6R_1 = (100 \times 5) + (40 \times 1)$$

$$\therefore R_1 = 90 \text{ KN}$$

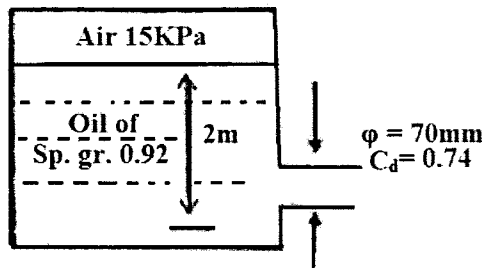


6. (a) Draw the rheological diagram for Newtonian fluid, Non-Newtonian fluid and ideal plastic. 4.5

Answer: Fundamental of Mechanical Engineering vol.-1, chapter-3.

(b) From the following figure calculate the rate of fluid flow:-

8



Solution: Given:

$$d = 70\text{mm} = 0.07\text{m}$$

$$C_d = 0.74, \text{ height of oil } Z_1 = 2\text{m} \text{ and air pressure } P = 15 \text{ kPa} = 15000\text{Pa}$$

$$\text{Density of oil } \rho = 0.92 \times 1000 = 920 \text{ kg/m}^3$$

Applying Bernoulli's equation

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$$

$$\Rightarrow \frac{15000}{920 \times 9.81} + 0 + 2 = 0 + \frac{V_2^2}{2g} + 0$$

$$\Rightarrow 3.66 = \frac{V_2^2}{2g}$$

$$\therefore V_2 = 8.47 \text{ m/s}$$

Rate of fluid flow,

$$Q = C_d a_2 V_2 = 0.74 \times \frac{\pi \times 0.07^2}{4} \times 8.47 = 0.02412 \text{ m}^3/\text{s} \text{ (Answer)}$$

7. (a) What are the requirements of a good shaft coupling? Write the name of five rigid coupling. 6

Requirements of good shaft coupling:

A good shaft coupling should have the following requirements :

1. It should be easy to connect or disconnect.
2. It should transmit the full power from one shaft to the other shaft without losses.
3. It should hold the shafts in perfect alignment.
4. It should reduce the transmission of shock loads from one shaft to another shaft.
5. It should have no projecting parts.

Five rigid coupling:

1. Clamp coupling
2. Flange coupling
3. Muff coupling
4. Beam coupling
5. Bushed pin coupling.

(b) A circular shaft can transmit at work of 5 KN-m. in the topic is reduced to 4 KN-m, then what is the maximum value of bending moment that can be applied to the shaft? 6.5

Solution: Given; $T_{\max} = 5 \text{ KN.m}$

$$T_{\min} = 4 \text{ KN.m}$$

Moment, $M = ?$

We know,

$$M = \sqrt{(T_{\max}^2 - T_{\min}^2)} = \sqrt{(5^2 - 4^2)} = 3 \text{ KN.m (Answer)}$$

8. (a) Define sensible heating and dehumidification.

4

Sensible heating: The heating of air, without any change in its specific humidity is called sensible heating.

Dehumidification: The removal of moisture from the air, without change in its dry bulb temperature is called dehumidification.

(b) An electric cable of aluminum ($K=240 \text{ w/mk}$) is to be insulated with 8.5 rubber ($k=0.15 \text{ w/mk}$). The cable is to be located in air ($K=0.15 \text{ w/mk}$). The cable is to be located in air ($K= 6 \text{ w/m}^2$) Calculate the critical thickness of insulation.

Solution:

$$\text{Critical thickness of insulation} = \frac{k}{h} = \frac{0.15}{6} = 0.025\text{m} = 25\text{mm (Answer)}$$

9.(a) Write the differences between boiler mountings and accessories.

4

Boiler Mountings	Boiler Accessories
They ensure boiler safety.	They improve boiler efficiency
They are essential.	They are not essential
Commonly they are mounted on boiler shell.	They are not located in the boiler shell.
Boiler is not operated without the mountings.	Boiler is run without use of boiler accessories.
Boiler mounting reduces boiler accident.	Boiler Accessories increases boiler performance.
Boiler mounting occupies less floor space.	Boiler accessory occupies comparatively greater floor space.
Example Pressure gauge, water level indicator etc.	Example Super heater, Economiser, etc.

(b) In a boiler feed water supplied per hour 205kg, while coal fired per hour 23kg. The net enthalpy rise per kg of water is 145kJ. If the calorific value of the 8.5 coal is 2050kJ/kg, then calculate the boiler efficiency (Assume any other data if needed).

Solution:

$$\text{Given, } m_s = 205 \text{ kg/h}$$

$$m_f = 23 \text{ kg/h}$$

$$h - h_1 = 145 \text{ KJ/kg}$$

Calorific value of coal, $C = 2050 \text{ KJ/kg}$

We know,

$$\text{Boiler efficiency} = \frac{m_s (h - h_1)}{m_f \times C} = \frac{205 \times 145}{23 \times 2050} = 0.63 = 63\% \text{ (Answer)}$$

10.(a) Draw a neat sketch of a household refrigerator system and explain its working principle. 7

Answer: Fundamentals of Mechanical Engineering vol.-1, chapter-6.

(b) Write the properties of a good refrigerant. 5.5

Answer: Fundamentals of Mechanical Engineering vol.-1, chapter-6.

11(a) For a both end fixed column made of AISI 1020 rolled steel (tensile strength 650 MPa) find the buckling load under the following condition ($l=2.5\text{m}$); 8

(i) Column is round with cross sectional area 475 mm^2

(ii) Column is a circular tube with inner radius 50mm and cross sectional area 475 mm^2

(iii) Column is rectangle with one side length double the other side length and cross sectional area 475 mm^2 .

(b) Define the followings: 4.5

(i) Shock wave

(ii) Oblique wave

(iii) Mack cone

Shock wave: It is a strong pressure wave in any elastic medium such as air, water or a solid substance, produced by supersonic aircraft, explosions, lightning or other phenomena that create violent change in pressure.

Oblique wave: An oblique shock wave is a shock wave that, unlike a normal shock, is inclined with respect to the incident upstream flow direction. It will occur when a supersonic flow encounters a corner that effectively turns the flow into itself and compresses. The upstream streamlines are uniformly deflected after the shock wave.

Mack cone: Tangent drawn to the different circle on both sides, which represent the propagated spherical waves, then a cone is produced called Mack cone.

Or

The conical pressure wave front produced by a body moving at a speed greater than that of sound.

12.(a) Define grey body, specular surface and diffuse surface. 4.5

Grey body: A grey body is defined as one whose absorptivity of a surface does not vary with temperature and wavelength of the incident radiation.

Specular surface: A specular surface is one where each point on the surface is level with another. It is a near-perfect flat surface. After reflection from a specular surface, light rays are parallel to each other and are heading in the same direction. The wave fronts remain unchanged here.

Diffuse surface: A diffuse surface is one where each point on the surface is on a different level than another. It is a jagged surface with varying protrusions and troughs. After reflection from a diffuse surface, light rays aren't parallel to each other but are at an angle,

and are heading in different directions. The wave fronts that were previously present are now broken and do not exist.

(b) A composite wall is made of followings:

8

(i) An inner layer of 20cm thick made of fire clay brick ($k=1.47 \text{ w/mK}$)

(ii) Middle layer made of earth brick of 15cm thick ($k=0.24 \text{ w/mK}$)

(iii) The outer layer with different type of clay 10cm thick ($k=0.09 \text{ w/mK}$)

If the temperature of the inner wall surface is 1050°C and outer wall surface 150°C , calculate the amount of heat loss through this composite wall.

Solution:

Given;

Inner layer thickness, $x_i = 20\text{cm} = 0.2\text{m}$ and $k_i = 1.47 \text{ w/mK}$

Middle layer thickness, $x_m = 15\text{cm} = 0.15\text{m}$ and $k_m = 0.24 \text{ w/mK}$

Outer layer thickness, $x_o = 10\text{cm} = 0.1\text{m}$ and $k_o = 0.09 \text{ w/mK}$

$T_i = 1050^\circ\text{C} = 1323\text{K}$ and $T_o = 150^\circ\text{C} = 423\text{K}$

$$\text{Heat loss, } \frac{\dot{Q}}{A} = \frac{T_i - T_o}{\frac{x_i}{k_i} + \frac{x_m}{k_m} + \frac{x_o}{k_o}} = \frac{1323 - 423}{\frac{0.2}{1.47} + \frac{0.15}{0.24} + \frac{0.1}{0.09}} = 480.73 \text{ w/m}^2 \quad (\text{Answer})$$

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MECHANICAL ENGINEERING**Subject Code:**

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Second Paper**Time Allowed-3 hours****Full Marks-100****[N.B.- Answer any five questions. The figures in the margin indicate full marks.]****1. (a) Define and explain the following:-****9****(i) Free vibration (ii) Forced Vibration (iii) Damped Vibration****Answer:** Fundamentals of Mechanical Engineering vol.-1, chapter-8.**(b) State and explain the primary and secondary balancing of IC engine.****6**

Primary balancing: The primary balance of an engine refers to vibrations which occur at the fundamental frequency (first harmonic) of the engine speed. These vibration therefore occur at a frequency equal to the crankshaft speed. Primary balance is the balance achieved by compensating for the eccentricities of the masses in the rotating system, including the connecting rods. Primary balance is controlled by adding or removing mass to or from the crankshaft, typically at each end, at the required radius and angle, which varies both due to design and manufacturing tolerances. In theory any conventional engine design can be balanced perfectly for primary balance.

Secondary balancing: Secondary balance can include compensating (or being unable to compensate) for:

i)The kinetic energy of the pistons.

ii)The non-sinusoidal motion of the pistons.

iii)The sideways motion of balance shaft weights.

The second of these is the main consideration for secondary balance. There are two main control mechanisms for secondary balance - matching the phasing of pistons along the crank, so that their second order contributions cancel, and the use of Lanchester balance shafts, which run at twice engine speed, and so can provide a counteracting force

(c) Describe the necessity of balancing of rotating parts for high speed engines.**5**

Necessity: Reasons for balancing of rotating elements of machine: The balancing of the moving parts both rotating and reciprocating of such machine is having greater importance. Because, if these parts are not balanced properly then the unbalanced dynamic forces can cause serious consequences, which are harmful to the life of the machinery itself, the human beings and all the property around them. These unbalanced forces not only increase the load on the bearings and stresses in various members, but also produces

unpleasant and dangerous vibrations in them.

2. (a) Briefly discuss the requirements for a good compression ignition engine fuel. 3

Requirement for a good CI engine fuel:

1. Knock Characteristics: A good CI engine fuel should have short ignition lag and will ignite more rapidly to reduce knock.
2. Volatility: The fuel should be sufficiently volatile in the operating range of temperature to produce good mixing and combustion.
3. Starting Characteristics: The fuel should help in starting the engine easily.
4. Smoking and odor: The fuel should not promote either smoke or odor in the engine exhaust.
5. Viscosity: CI engine fuel should be able to flow through the fuel system and the strainers under the lowest operating temperature to which the engine is subjected to.
6. Corrosion and wear: The fuel should not cause corrosion and wear of the engine components before or after combustion.
7. Handling ease: The fuel should be a liquid that will readily flow under all conditions that are encountered in actual use.

(b) List the similarities and dissimilarities in combustion process of IC engine. 6

(c) State the characteristics of premixed and non premixed flames. 4

Premixed flame: In premixed flame, fuel and oxidizer are mixed before the flame. The stoichiometry of the mixture can be controlled by changing the fuel to oxidized ratio and an inert gas such as nitrogen may be used to dilute the reactants and alter the flame temperature.

Non-premixed flame: In a non-premixed flame, only fuel is supplied to the burner. The oxidizer is supplied from ambient air and the mixing and combustion reactions takes place together. The structure of the flame, with its central fuel core and the outer reaction zone can be seen by looking at the colors associated with these regions. Soot formed in the reaction acts as a black body and the yellow color at the outer and higher regions of the flame indicates its present.

(d) Explain the terms “cogeneration” and “combined power cycle”. Write about their suitability in context to energy situation in Bangladesh. 7

Cogeneration: Cogeneration is the production of more than one useful form of energy (Such as process heat and electric power) from the same energy source.

Cogeneration is a more efficient use of fuel because otherwise-wasted heat from electricity generation is put to some productive use. Combined heat and power (CHP) plants recover otherwise wasted thermal energy for heating. This is also called combined heat and power district heating. Small CHP plants are an example of decentralized energy. By-product heat at moderate temperatures can also be used in absorption refrigerators for cooling.

Combined power cycle: A combined cycle power plant is an assembly of heat engines that work in tandem from the same source of heat, converting it into mechanical energy. On land, when used to make electricity the most common type is called a **combined cycle gas turbine (CCGT)** plant. The same principle is also used for marine propulsion, where it is called a combined gas and steam (COGAS) plant. Combining two or more thermodynamic cycles improves overall efficiency, which reduces fuel costs.

The principle is that after completing its cycle in the first engine, the working fluid (the exhaust) is still hot enough that a second subsequent heat engine can extract energy from the heat in the exhaust. Usually the heat passes through a heat exchanger so that the two engines can use different working fluids.

Suitability of cogeneration: It is suitable because;

- i) Cogeneration significantly reduces the carbon emission and energy cost.
- ii) Enhancing operational efficiency to lower overhead cost.
- iii) Reducing energy waste, thereby increase energy efficiency
- iv) Offering greater energy independence by moving a portion of the load off the grid

Suitability of combined power cycle:

1. High overall plant efficiency
2. Low investment costs
3. Small amount of water required
4. Great operating flexibility
5. Phased installation
6. Simplicity of operation
7. Low environmental impact

3. (a) Define with examples : (i) Mechanism and (ii) Inversion mechanism

3

Mechanism: When one of the links of a kinematic chain is fixed, the chain is known as mechanism.

Example: Engine indicator, typewriter

Inversion of mechanism: The method of obtaining different mechanisms by fixing different links in a kinematic chain, is known as inversion of mechanism.

Example: The inversion of four bar chain are given below;

- i) Beam engine
- ii) Coupling rod of a locomotive

Inversion of single slider crank chain;

- i) Bull engine
- ii) Oscillating cylinder engine

(b) What is quick return mechanism? Draw a schematic of crank shaper quick return mechanism and explain its use.

7

Quick return mechanism: A quick return mechanism is an apparatus to produce a reciprocating motion in which the time taken for travel in return stroke is less than in the forward stroke.

Schematic diagram and explain:

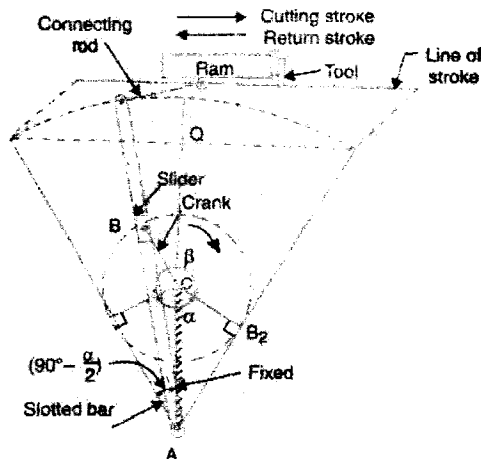


Fig. Crank shaper quick return mechanism

This quick return mechanism is mostly used in shaping machines, slotting machines and in rotary internal combustion engines. In this quick return mechanism, the link AC (i.e. link 3) forming the turning pair is fixed, as shown in fig. The link 3 corresponds to the connecting rod of a reciprocating steam engine. The driving crank CB revolves with uniform angular speed about the fixed centre C. A sliding block attached to the crank pin at B slides along the slotted bar AP and thus causes AP to oscillate about the pivoted point A. A short link PR transmits the motion from AP to the ram which carries the tool and reciprocates along the line of stroke R_1R_2 . The line of stroke of the ram (i.e. R_1R_2) is perpendicular to AC produced. The extreme positions, AP_1 and AP_2 are tangential to the circle and the cutting tool is at the end of the stroke. The forward or cutting stroke occurs when the crank rotates from the position CB_1 to CB_2 (or through an angle β) in the clockwise direction. The return stroke occurs when the crank rotates from the position CB_2 to CB_1 (or through angle α) in the clockwise direction.

(c) The crank of a reciprocating engine is 200mm long, and the connecting rod is 800mm long. Find the acceleration of the connecting rod and the velocity and acceleration of the piston when the crank is rotated from inner dead position. The crank turns at a uniform speed of 200 rpm.

Solution: Given;

$$N = 200 \text{ rpm} \therefore \omega = \frac{2\pi N}{60} = \frac{2\pi \times 200}{60} = 20.944 \text{ rad/s}$$

$$r = 200 \text{ mm} = 0.2 \text{ m}$$

$$l = 800 \text{ mm} = 0.8 \text{ m}$$

$$\therefore n = \frac{l}{r} = \frac{0.8}{0.2} = 4$$

$$\text{let, } \theta = 0^\circ$$

Acceleration of the connecting rod,

$$\alpha_c = \frac{\omega^2 \sin \theta (n^2 - 1)}{[n^2 - (\sin \theta)^2]^{3/2}} = \frac{20.944^2 \sin 0 (4^2 - 1)}{[4^2 - (\sin 0)^2]^{3/2}} = 0 \text{ rad/s}^2 \text{ (Answer)}$$

Velocity of the piston,

$$V_p = \omega r \left(\sin \theta + \frac{\sin 2\theta}{2n} \right) = 0 \text{ m/s (Answer)}$$

Acceleration of the piston,

$$a_p = \omega^2 r \left(\cos \theta + \frac{\cos 2\theta}{n} \right) = 20.944^2 \times 0.2 \left(\cos 0 + \frac{\cos(2 \times 0)}{4} \right) = 109.66 \text{ m/s}^2 \text{ (Answer)}$$

4. (a) Explain the differences among simple, compound and epicyclic gear trains. 8
What are the advantages of epicyclic gear trains?

Simple gear train	Compound gear train	Epicyclic gear train
Only one gear in each shaft and there is a relative motion between shaft axis.	There is more than one gear on the shaft which is rigidly fixed and meshed with the gear on another shaft forming gear train.	The axis of shaft on which the gear are mounted may move relative to the fixed axis
For large speed reduction, large size of gear is required.	For large speed reduction the small gear ratio is required.	For large speed reduction in high velocity moderate size gear is required.

Special advantages of epicyclic gear train:

1. Coaxial arrangement of input shaft and output shaft
2. Load distribution to several planetary gears
3. High efficiency due to low rolling power
4. Almost unlimited transmission ratio options due to combination of several planet stages
5. Suitable as planetary switching gear due to fixing this or that part of the gearbox
6. Possibility of use as overriding gearbox
7. Favorable volume output
8. Suitability for a wide range of applications

(b) What is centrifugal tension in a belt? How does affect power transmission? 6

Centrifugal tension: The tension caused by centrifugal force called centrifugal tension. At lower belt speeds (less than 10 m/s), the centrifugal tension is very small, but at higher belt speeds (more than 10 m/s), its effect is considerable and thus should be taken into account.

Effect:

Usually, power transmission is proportional to belt speed.

However, at very high belt speeds which are usually above 1500 m/min, the power decreases with increase in the belt speed due to rapid rise of centrifugal force acting on the

belt. This centrifugal force reduces the pressure between the belt and the rim of the pulleys, and thus, moves the belt away from the pulley and reduces the wrap angle. Therefore, the belt tensions and power transmission also are reduced.

(c) Discuss relative merits and demerits of belt, rope and chain drive for power transmission. 6

Merits of belt drive:

- i) They are simple and economical.
- ii) They can transmit Power over a considerable distance.
- iii) They can protect the machine from overloading by slipping of the belt over a pulley.
- iv) Belt drive can absorb shock and damp vibration.
- v) The operation is smooth and silent.
- vi) They are durable and require very little maintenance.

Demerits of belt drive:

- i) Limited Speed range.
- ii) They are not compact.
- iii) Considerable power loss.
- iv) Short service life compared to other mode power transmission.
- v) The velocity ratio may vary due to belt slip
- vi) They inflict a heavy load on shafts and bearings.

Merits of rope drive:

- i) Significant power transmission.
- ii) It can be used for long distance.
- iii) Ropes are strong and flexible.
- iv) Provides smooth and quiet operation.
- v) It can run any direction.
- vi) Low-cost and economic.
- vi) Precise alignment of the shaft not required.

Demerits of rope drive:

- i. Internal failure of the rope has no sign on external, so it is often get unnoticed
- ii. Corrosion of wire rope.
- iii. High maintenance cost
- iv. Less reliable

Merits of chain drive:

- i. They can be used for both long and short distances
- ii. A number of shafts can be driven from a single chain
- iii. They are compact and have small overall dimensions
- iv. They do not present fire hazard
- v. Temperature and environmental conditions do not affect their working
- vi. They do not require initial tension
- vii. They have very high efficiency (up to 96%)
- viii. They do not slip

- ix) They are easier to install
- x) They can withstand abrasive conditions
- xi) They can operate in wet conditions

Demerits of chain drive:

- i) They can not be used where slip is the system requirement
- ii) They require precise alignment compared to belt drives
- iii) They require frequent lubrication
- iv) They have less load capacity compared with gear drives
- v) Their operation is noisy and can cause vibrations
- vi) They are not suitable for non-parallel shafts
- vii) They can not be used where precise motion is required
- viii) They require housing
- viii) They require adjustments for slack like tensioning device

5. (a) Show the open belt and cross belt arrangements for power transmission. 3
Which one can transmit more power and why?

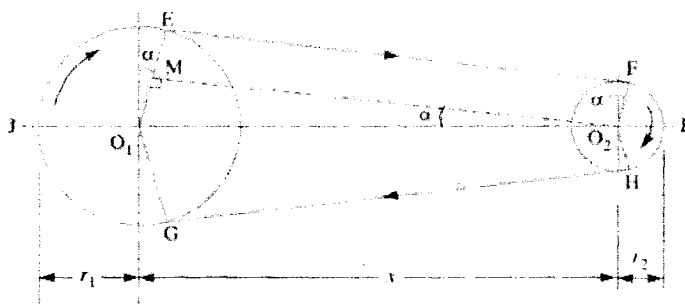


Fig. open belt arrangement

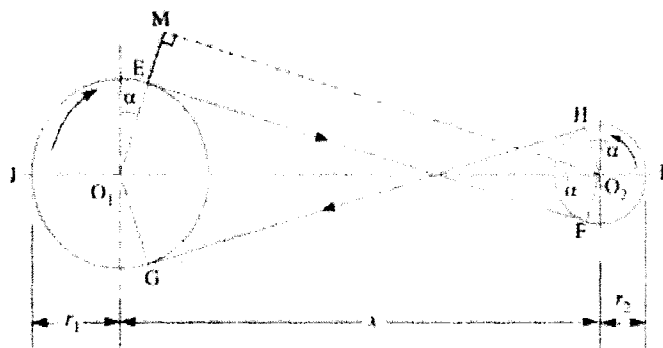


Fig. cross belt arrangement

Which can transmit more power?

A cross-belt drive can transmit more power than an open-belt due to the larger angle of contact between the belt and the pulley.

(b) Explain, what is meant by “creep” of a belt. Discuss the advantages and disadvantages of power transmission by belt and gear. 5

Creep: When the belt passes from the slack side to the tight side, a certain portion of the belt extends and it contracts again when the belt passes from the tight side to slack side. Due to these change of length, there is a relative motion between the belt and pulley surfaces. This relative motion is called creep.

Advantages of belt:

- i) They are simple and economical.
- ii) They can transmit Power over a considerable distance.
- iii) They can protect the machine from overloading by slipping of the belt over a pulley.
- iv) Belt drive can absorb shock and damp vibration.
- v) The operation is smooth and silent.
- vi) They are durable and require very little maintenance.

Disadvantages of belt:

- i) Limited Speed range.
- ii) They are not compact.
- iii) Considerable power loss.
- iv) Short service life compared to other mode power transmission.
- v) The velocity ratio may vary due to belt slip
- vi) They inflict a heavy load on shafts and bearings.

Advantages of gear:

- i. It is positive drive hence velocity remains constant
- ii. Provisions for changing velocity ratios can be made with the help of gear box
- iii. Its efficiency is very high
- iv. It can be used even for low speeds
- v. It can transmit high torque values
- i. It is compact in construction

Disadvantages of Gear drive

- i) They are not suitable when shafts are distant
- ii) At high speeds noise and vibration happens
- iii) It requires lubrication
- iv) It has no flexibility

(c) Power is transmitted from a shaft rotating at 250 rpm by 10 ropes running in 12 grooves in the periphery of a wheel of effective diameter 1.65 meters (to the center line of the rope), the groove angle is 50° and the arc of contact round the wheel rim is 180° . The maximum permissible load in each rope is 900 N and its mass is 0.55 kg/m. If the coefficient of friction between the rope and wheel surface is 0.3, what power can be transmitted under above condition?

Solution:

Given;

$$D = 1.65\text{m and } N = 250\text{rpm}$$

$$2\beta = 50^\circ \therefore \beta = 25^\circ \text{ and } \theta = 180^\circ = 3.1416 \text{ rad}$$

$$T = 900\text{N}$$

We know that velocity of the rope,

$$v = \frac{\pi DN}{60} = \frac{3.1416 \times 1.65 \times 250}{60} = 21.6 \text{ m/s}$$

$$\therefore \text{Centrifugal tension, } T_c = mv^2 = 0.55 \times 21.6^2 = 256.61\text{N}$$

Tension in the tight side of the rope,

$$T_1 = T - T_c = 900 - 256.61 = 643.39\text{N}$$

 T_2 = Tension in the slack side of the rope

We know that,

$$\frac{T_1}{T_2} = e^{\mu\theta \operatorname{cosec} \beta}$$

$$\therefore T_2 = \frac{T_1}{e^{\mu\theta \operatorname{cosec} \beta}} = \frac{643.39}{e^{0.3 \times 3.1416 \times \operatorname{cosec} 25}} = 69.18\text{N}$$

So, power transmitted per rope

$$P = (T_1 - T_2)v = (643.39 - 69.18) \times 21.6 = 12402.94 \text{ W} = 12.4029\text{KW}$$

$$\therefore \text{Total power transmitted} = 12.4029 \times 10 = 124.029 \text{ KW (Answer)}$$

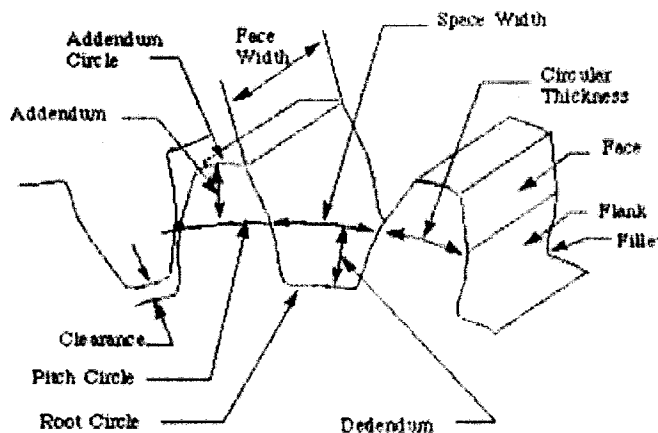
6. (a) Draw a spur gear tooth and label it.**4**

Fig. Spur gear teeth

(b) What is meant by conjugate action of gear teeth?**3**

Conjugate action of gear teeth: A pair of transverse gear tooth profiles is said to be conjugate if a constant angular velocity of one profile produces a constant angular velocity in the meshing profile.

(c) Write the advantages and disadvantages of worm gear over bevel gear.

4

Advantages:

1. Higher speed reduction could be secured; speed reduction could be secured up to 300: 1
2. Worm and worm gears operate silently
3. Worm and worm gears will have one characteristics i.e. self-locking. Reverse movement will be restricted but this characteristic depends on lead angle and friction angle, we have discussed this concept in our discussion in previous post during study of worm and worm gear.
4. Worm and worm gear unit will be preferred to use if space is restricted as we have already discussed that worm and worm gear unit could be used for heavy speed reduction in compact space also.
5. Handsome output torque will be secured here with the application of worm and worm gear.

Disadvantages:

1. Manufacturing cost is heavy as compared with manufacturing cost of bevel gear
2. Cost of raw material to manufacture the worm and worm gear set will be quite high
3. Worm and worm gear set will have heavy power losses.
4. Efficiency will be low
5. If speed reduction ratio is large, worm teeth sliding action will create lots of heat
6. Lubrication scheduled must be strictly maintained for healthiness of worm and worm gear as this unit requires much lubrication for smooth working of gearbox.

(d) Describe the working principle of a cooling system for I.C engine.

8

Principle:

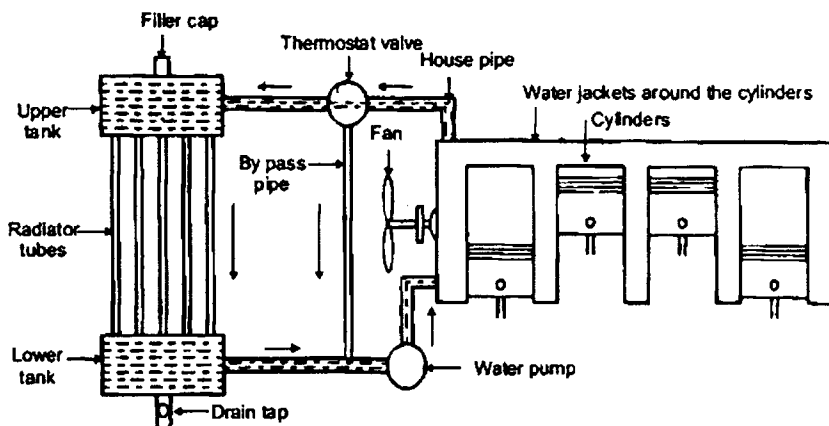


Fig. Cooling system of IC Engine

It consists mainly four components Radiator, fan, water pump and Thermostat. The water or coolant is circulated through a jacket around the parts of the engine to be cooled, and is kept in motion by centrifugal pump which is driven by the engine. The water is passed

through the radiator where it is cooled by the air drawn through the radiator by a fan and by the air draft to the forward motion of the vehicle. A thermostat is used to control the water temperature required for cooling.

7. (a) Explain the differences among true centrifugal casting, semi centrifugal casting and centrifuging. State the advantages of centrifugal casting over other methods.

True centrifugal casting: True centrifugal casting technique is employed when producing parts an axis symmetrical, with a uniform diameter. It contains a cylindrical mold that rotates about its axis at specific speed. Molten metal is poured through the center, which is thrown to the wall of the mold. Thickness in this type of casting is determined by the amount of poured liquid metal. Core is not required just as semi-centrifugal casting. It also has fast production rate and offers very high quality.

Semi centrifugal casting: Semi-centrifugal casting is similar to true centrifugal casting but they have slight difference. It is carried out on a vertical mounted machine. In this type of centrifugal casting, more than one items can be produced at a time.

Centrifuging: This casting is used in unsymmetrical casting in groups. It is carried out in group in order to produce equal parts in the hole casting. Rotation axis of the mold does not coincide with each other in this casting.

True centrifugal casting	Semi centrifugal casting	Centrifuging
Long horizontal mould	Short single mould	Central sprue with attachment moulds
Rotates on X-axis	Rotates on Y-axis	Rotates on Y-axis
Casts possess rotational symmetry	Casts possess rotational symmetry	Casts may or may not possess rotational symmetry
For pipes exclusively	For casts with central parts worked out hollow	For free from casts

Advantages of centrifugal casting:

1. Casting obtain elevated density, high Mechanical strength and excellence grained structure.
2. This castings have a directional solidification starting as of outside to inside.
3. Structure of hollow interiors with no core.
4. Inclusion and impurities are lighter
5. Gates and riser are not required.

(b) Distinguish between brazing and welding.

Answer: Similar to the Question of 40th BCS

(c) What is spot welding and how does it differ from roll spot welding and the projection welding? What are the advantages of these processes?

Spot welding: Spot welding (or resistance spot welding) is a type of electric resistance welding used to weld various sheet metal products, through a process in which contacting metal surface points are joined by the heat obtained from resistance to electric current.

Spot welding	Roll spot welding
Spot welding is the most common form of resistance welding and is best known for its speed and ability to produce a lot of welds in a short amount of time. No filler metal is needed, it is energy efficient and it is also relatively easy to learn.	Roll spot and seam welding is restricted to a straight line or uniformly curved line. And a relatively higher current is required for seam welding than spot welding
Spot welding cannot be used for thicker metal and the welds can be weak. Plus, they are not very attractive looking. Additionally, spot welders can be more expensive than other welders.	Roll spot and seam welding produces gas-tight and liquid-tight joints, which are needed when welding things like fuel tanks. It also produces less overlap than spot welds.

Spot welding	Projection welding
Spot welding is the most common form of welding and differs from projection welding in a number of ways. This process is typically used to connect large components or sheets of metal using metal currents along the joint. The current is directed at one point as opposed to the multiple projections found with projection welding and requires more current and pressure. Spot welding is particularly useful for corners and thin materials.	Projection welding is more useful for thick metal materials and products that require an exceptionally strong weld, since less heat and pressure during the welding process yield a stronger joint. Projection welds are also less visible than spot welds, allowing for a more aesthetically pleasing finished appearance. Projection welds can also be used to weld a nut, stud, or projection on steel and is used in many automotive assemblies.

Advantages of spot welding:

1. In this type of welding the base metal does not undergo to large heat affected area.
2. This type of welding is a easy process.
3. Spot welding has a high production rate.
4. Spot welding can be applied to different metals to join.
5. Spot welding is a low-cost process.
6. There is a possible to weld multiple metals at a time.
7. It can be operated through automatic and manual type.
8. Thin metals can be welded more efficiently.
9. It does not require more skilled persons at operation.

Advantages of roll spot welding:

1. It can create airtight and watertight seals.
2. Fast weld process
3. There is no need of using flux and filler metal
4. It is smooth and clean process.

Advantages of projection welding:

1. The welding current intensely works on any individual parts using the profile or projection.
2. Electrodes with large flat contact area can be used on the full or half identical area of the work piece.
3. Even electrodes come with more lifespan. It does not make any deformation of discoloration on the project and fits well in high-volume production works.
4. The method of resistant welding method is designed to allow multi-projection welding. Resulting, some electrodes or a pair of large surface electrodes is fed from a solo power source.

8. Write short notes on the following :-

- (i) Personnel management;
- (ii) Technology management;
- (iii) Matrix Organization;
- (iv) Tool geometry;
- (v) Motivation theory

20

(i) Personnel management:

1. Personnel management includes the function of employment, development and compensation- These functions are performed primarily by the personnel management in consultation with other departments.
2. Personnel management is an extension to general management. It is concerned with promoting and stimulating competent work force to make their fullest contribution to the concern.
3. Personnel management exists to advise and assist the line managers in personnel matters. Therefore, personnel department is a staff department of an organization.
4. Personnel management lays emphasize on action rather than making lengthy schedules,

plans, and work methods. The problems and grievances of people at work can be solved more effectively through rationale personnel policies.

5. It is based on human orientation. It tries to help the workers to develop their potential fully to the concern.

6. It also motivates the employees through its effective incentive plans so that the employees provide fullest co-operation.

7. Personnel management deals with human resources of a concern. In context to human resources, it manages both individual as well as blue-collar workers.

(ii) Technology Management:

1. It provides required leverage to the organization for emerging as a world leader in the field.

2. It facilitates technological innovation to work as key participant in the field and that 'Innovate or perish' would be the guiding principle followed all over the world.

3. It commercializes technological advancements for the organization and sets the innovation as the name of the game. It is 'not resources but being resourceful', that mattered in today's highly competitive world.

4. It gives capability to face the enormous changes for industry in the era of globalization.

5. It develops capacity to become a technological super-power and in order to shine in the comity of nations we need to be technologically superior.

(iii) Matrix organization:

1. It offers operational freedom and flexibility.

2. It seeks to optimize the utilization of resources.

3. It focuses on end results.

4. It maintains professional identity.

5. It holds an employee responsible for management of resources.

6. It calls for greater degree of coordination.

7. It violates unity of command principle.

8. It may be difficult to define authority and responsibility precisely.

9. Employees may find it frustrating to work with two bosses.

(iv) Tool geometry: The tool must have a specific geometry (known as tool geometry) for effective cutting and smooth surface finish.

Shank:

This is the main body of the tool. The shank is used to hold the tool (i.e tool holder).

Flank:

The surface or surface below and adjacent to the cutting edge is called flank of the tool.

Face:

The surface on which the chips slide is called the face of the tool.

Heel:

It is the intersection of the flank and the base of the tool. It is a curved portion at the bottom of the tool.

Nose:

It is the point where the side cutting edge and end cutting edge intersects.

Nose radius:

The nose radius will provide long life and also good surface finish with it a sharp point on the nose.

Cutting edge:

It is the edge on the face of the tool which removes the material from the work piece.

The tool cutting edge consists of side cutting edge (major cutting edge), end cutting edge (minor cutting edge and the nose).

Side cutting edge angle:

This angle also is known as the lead angle. This is the angle between the side cutting edge and side of the tool shank.

End cutting edge angle:

This is the angle between the end cutting edge and a line normal to the tool shank.

Side relief angle:

It is the angle between the portion of the side flank immediately below the side cutting edge and a line perpendicular to the base of the tool and measured at the right angle to the end flank.

End relief angle:

It is the angle between the portion of the end flank immediately below the end cutting edge and a line perpendicular to the base of the tool and measured at the right angle to the end flank.

Back rack angle :

It is the angle between the tool face and a line parallel to the base of the tool and measured in a plane perpendicular through the side cutting edge.

The back rack angle is positive if the side cutting edge slopes downwards from the point towards the shank and The back rack angle is negative if the slope is side cutting edge is reversed.

Side rack angle:

It is the angle between the tool face and a line parallel to the base of the tool and measured in a plane perpendicular to the base and the side cutting edge.

This angle gives the slope of the face of the tool from the cutting edge.

(v) Motivation theory:

Motivation is a huge field of study. There are many theories of motivation. Some of the famous motivation theories include the following:

1. Maslow's hierarchy of needs

Abraham Maslow postulated that a person will be motivated when his needs are fulfilled. The need starts from the lowest level basic needs and keeps moving up as a lower level need is fulfilled. Below is the hierarchy of needs:

Physiological: Physical survival necessities such as food, water, and shelter.

Safety: Protection from threats, deprivation, and other dangers.

Social (belongingness and love): The need for association, affiliation, friendship, and so on.

Self-esteem: The need for respect and recognition.

Self-actualization: The opportunity for personal development, learning, and fun/creative/challenging work. Self-actualization is the highest level need to which a human being can aspire.

2. McClelland's theory of needs

McClelland affirms that we all have three motivating drivers, and it does not depend on our gender or age. One of these drives will be dominant in our behaviour. The dominant drive depends on our life experiences.

The three motivators are:

Achievement: a need to accomplish and demonstrate own competence People with a high need for achievement prefer tasks that provide for personal responsibility and results based on their own efforts. They also prefer quick acknowledgement of their progress.

Affiliation: a need for love, belonging and social acceptance People with a high need for affiliation are motivated by being liked and accepted by others. They tend to participate in social gatherings and may be uncomfortable with conflict.

Power: a need for control own work or the work of others People with a high need for power desire situations in which they exercise power and influence over others. They aspire for positions with status and authority and tend to be more concerned about their level of influence than about effective work performance.

3. McGregor's theory X and theory Y:

Douglas McGregor formulated two distinct views of human being based on participation of workers. The first is basically negative, labelled as Theory X, and the other is basically positive, labelled as Theory Y. Both kinds of people exist. Based on their nature they need to be managed accordingly.

Theory X: The traditional view of the work force holds that workers are inherently lazy, self-centred, and lacking ambition. Therefore, an appropriate management style is strong, top-down control.

Theory Y: This view postulates that workers are inherently motivated and eager to accept responsibility. An appropriate management style is to focus on creating a productive work environment coupled with positive rewards and reinforcement.

34th BCS

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MECHANICAL ENGINEERING

Subject Code:

9 0 1

FIRST PAPER

Time Allowed-3 hours

Full Marks-100

[N.B.- Answer any five questions. The figures in the margin indicate full marks.]

1.(a) How many laws of thermodynamics are there? Name them. 4

Answer: See at Fundamentals of mechanical engineering vol.-1, chapter-1

(b) State and explain first law of thermodynamics. 8

Answer: See at Fundamentals of mechanical engineering vol.-1, chapter-1

(c) A mixture of gas expands from 0.03 m^3 to 0.06 m^3 at a constant pressure of 1 MPa and absorbs 84 KJ of heat during the process. Find the change of internal energy. 8Solution: $\Delta E = \Delta Q + \Delta W$ $\Delta W = -P \Delta V$ Here, $P = 1 \text{ MPa}$, $\Delta V = 0.03 \text{ m}^3$ $W = -1 \text{ MPa} \times 0.03 \text{ m}^3 = -30 \text{ kJ}$ $\therefore \Delta E = -30 \text{ kJ} + 84 \text{ kJ} = 54 \text{ kJ}$ (Answer)

2. (a) How the boilers are classified? Show the classification in a tabular form. 5

According to	Types
Relative passage of water and hot gases	a) Water tube boiler b) Fire tube boiler
Water circulation arrangement	(a) Natural circulation (b) Forced circulation
According to use	(a) Stationary boiler (b) Portable boiler (c) Locomotive (d) Marine boiler
Position of the furnace	(a) Internally fired (b) Externally fired
Pressure of steam generated	(a) Low pressure boiler (b) Medium pressure boiler (c) High pressure boiler (d) Sub-critical boiler (e) Super-critical-boiler
The position of the Boiler	Horizontal, inclined or vertical

the charge in the furnace	(a) Pulverized fuel (b) Supercharged fuel (c) Fluidized bed combustion boilers
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(b) Name five mountings and accessories each. What is the function of fusible plug in boiler, describe. 8

Answer: Boiler mountings:

- 1) Safety valve
- 2) Water level indicator
- 3) Pressure gauge
- 4) Fusible plug
- 5) Steam stop valve

Boiler accessories:

- 1) Superheater
- 2) Economizer
- 3) Air preheater
- 4) Feed water pump
- 5) Steam injector

Function of Fusible plug: It is a very important safety device which protects the fire tube boiler shell against overheating. It is located just above the furnace in the boiler. It consists of a gunmetal plug fixed in a gunmetal body with a fusible molten metal. During the normal boiler operation, the fusible plug is covered by water and its temperature does not rise to its melting state. But when the water level falls too low in the boiler, it uncovers the fusible plug. The furnace gases heat up the plug, the fusible metal melts and the inner plug falls down. The water and steam then rush through the hole and extinguish the fire before any major damage occurs to the boiler due to overheating.

(c) A boiler evaporates 3.6 kg of water per kg of coal into dry saturated steam at 10 bar. The temperature of feed water is 32°C. Find the equivalent evaporation and the factor of evaporation. 7

Solution: Given, $m_e = 10 \text{ kg/kg of coal}$; $p = 10 \text{ bar}$; $t_1 = 32^\circ\text{C}$

From steam table, for 32°C , $h_f = 134 \text{ kJ/kg}$

And corresponding to a steam pressure of 10 bar, we find that $h = h_g = 2776.2 \text{ kJ/kg}$

$$\therefore \text{Equivalent evaporation} = \frac{m_e(h - h_f)}{2257} = \frac{3.6(2776.2 - 134)}{2257}$$

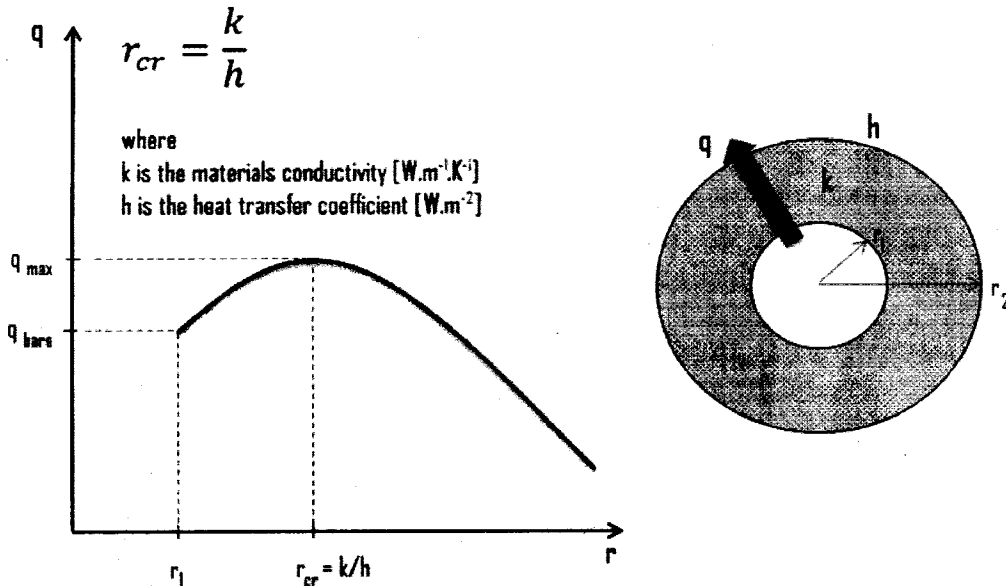
$$= 4.2 \text{ kg/kg of coal (Answer)}$$

$$\text{We know the factor of evaporation} = \frac{(h - h_f)}{2257} = \frac{(2776.2 - 134)}{2257} = 1.17 \text{ (Answer)}$$

3. (a) What is the critical thickness of insulation? Derive an expression to calculate the critical thickness in terms of typical known parameters. 8

Answer: Critical thickness of insulation: The thickness upto which heat flow increases and after which heat flow decreases is termed as critical thickness of insulation.

Critical Thickness of Insulation - Cylindrical Coordinates



(b) A steel ball having specific heat $0.46 \text{ KJ/Kg } ^\circ\text{C}$ and thermal conductivity $35 \text{ W/m}^2\text{K}$. Find the time required for the ball to attain a temperature of 150°C .

Answer: In this question data is insufficient, But the solution will be the similar of Question-15; Biman Bangladesh Airlines Ltd-2018.

Question may be the following:

A steel ball [$c=0.46 \text{ kJ/kg}^\circ\text{C}$, $k=35 \text{ W/m}^\circ\text{C}$] 5.0 cm in diameter and initially at a uniform temperature of 450°C is suddenly placed in a controlled environment in which the temperature is maintained at 100°C . The convection heat-transfer coefficient is $10 \text{ W/m}^2 \text{ } ^\circ\text{C}$. Calculate the time required for the ball to attain a temperature of 150°C .

4. (a) State Stefan Boltzman Law and Kirchhoff's law.

6

Answer: Stefan Boltzman Law: Stefan-Boltzmann law states that the total energy radiated per unit surface area of a black body across all wavelengths per unit time (also known as the black-body radiant emittance) is directly proportional to the fourth power of the black body's thermodynamic temperature T .

$$J = \sigma T^4$$

Kirchhoff's law: Kirchhoff's law of thermal radiation refers to wavelength-specific radioactive emission and absorption by a material body in thermodynamic equilibrium, including radioactive exchange equilibrium.

(b) An electric cable of aluminium ($K=210 \text{ W/M } ^\circ\text{K}$) is to be insulated with 8 rubber ($K=0.15 \text{ W/m } ^\circ\text{K}$) which located in free air ($h=6 \text{ W/m}^2\text{K}$). Calculate critical thickness.

Solution: Critical thickness, $r_{cr} = \frac{k}{h} = \frac{0.15}{6} = 0.025 \text{ m} = 25 \text{ mm}$ (Answer)

(c) Calculate the emission power of a black pot whose temperature is 60°C .

6

Solution:

Here, $T = 60^{\circ}\text{C} = 60 + 273 = 333\text{K}$

We know,

$$J = \sigma T^4 = 5.67 \times 10^{-8} \times 333^4 = 697.204 \text{ W/m}^2 \text{ (Answer)}$$

5. (a) Derive Bernoulli equation of fluid motion. What are the assumptions you made? 10

Answer: We know, Euler's equation of motion is $\frac{dP}{\rho} + g dz + v dv = 0$

Bernoulli's equation is obtained by integrating the Euler's equation,

$$\int \frac{dP}{\rho} + \int g dz + \int v dv = \text{constant}$$

If flow is incompressible, ρ is constant and

$$\frac{P}{\rho} + gz + \frac{v^2}{2} = \text{constant}$$

$$\text{Or } \frac{P}{\rho g} + z + \frac{v^2}{2g} = \text{constant}$$

$$\text{Or } \frac{P}{\rho g} + \frac{v^2}{2g} + z = \text{constant}$$

$$\frac{P}{\rho g} = \text{pressure energy per unit weight}$$

$$\frac{v^2}{2g} = \text{kinetic energy per unit weight}$$

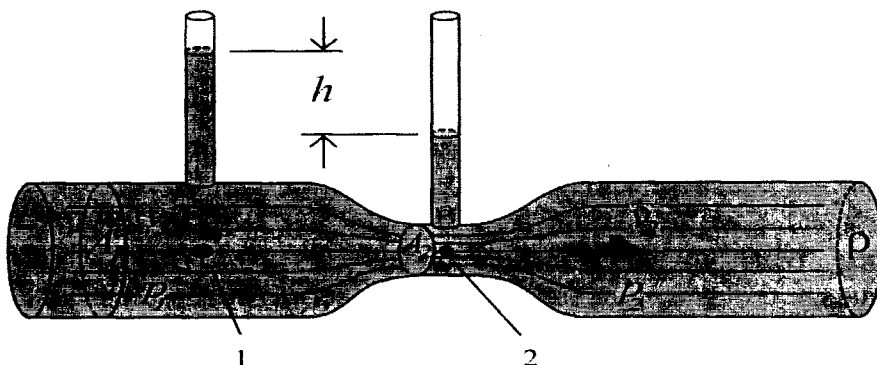
$$Z = \text{potential energy per unit weight}$$

Assumptions are:

- The fluid is ideal i.e. viscosity is zero
- The flow is steady
- The flow is incompressible
- The flow is irrotational

(b) Show how Bernoulli equation is used to measure flow rate through a venturi meter. Give free hand sketches. 10

Answer:



Applying Bernoulli's equation at point 1 and point 2,

$$\frac{P_1}{\rho g} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + z_2$$

As pipe is horizontal, $z_1 = z_2$

$$\text{So, } \frac{P_1 - P_2}{\rho g} = \frac{v_1^2}{2g} - \frac{v_2^2}{2g}$$

But $\frac{P_1 - P_2}{\rho g}$ is the pressure difference between 1 and 2 is equal to h or $\frac{P_1 - P_2}{\rho g} = h$.

$$\text{Now, } h = \frac{v_2^2}{2g} - \frac{v_1^2}{2g}$$

Applying continuity equation at section 1 and 2,

$$A_1 v_1 = A_2 v_2$$

$$\text{Or } v_1 = \frac{A_2 v_2}{A_1}$$

$$\text{So, } h = \frac{v_2^2}{2g} - \frac{\left(\frac{A_2 v_2}{A_1}\right)^2}{2g} = \frac{v_2^2}{2g} \left[\frac{A_1^2 - A_2^2}{A_1^2} \right]$$

$$\Rightarrow v_2^2 = 2gh \frac{A_1^2}{A_1^2 - A_2^2}$$

$$\Rightarrow v_2 = \sqrt{2gh \frac{A_1^2}{A_1^2 - A_2^2}}$$

$$\therefore \text{Discharge} = A_2 v_2 = A_2 \times \sqrt{2gh \frac{A_1^2}{A_1^2 - A_2^2}} = \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$$

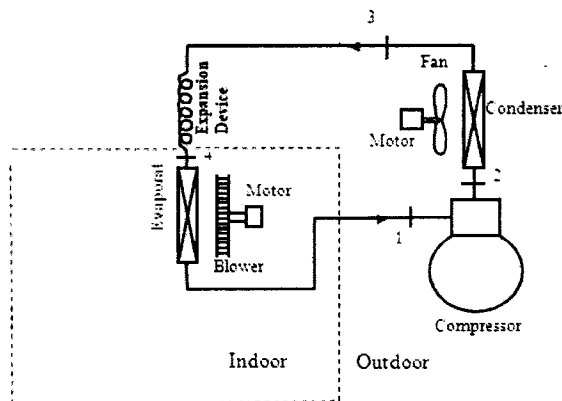
6. (a) With the help of a block diagram, describe the vapour compression 6 refrigeration system.

Answer: See at Fundamentals of Mechanical Engineering vol.-1, chapter-6.

(b) Give the free hand sketch of a split air cooler, explain it.

7.

Answer:



A split air cooler is also known as a remote mounted air cooler. It is basically a air conditioning system built in two distinct unit. The two units are: indoor unit and outdoor

unit. The indoor unit consists of a fan and cooling coil. It is located in the space to be conditioned. It is a well-designed single casing, well insulated on the inside housing the evaporator coil, twin blower system with a motor, capillary tubes for refrigerant expansion, electronic controls and condensate drain provision.

The outdoor unit consists of a compressor, condenser coil and propeller fan with motor. The outdoor unit is connected to an indoor unit by extended suction and liquid pipelines.

(c) Name at least five refrigerants, including two chlorine free ones with the 5 chemical formula, ASHRAE number and boiling point.

Answer:

1. Freon 12 (R-12) (boiling point: -30°C)
2. Freon 22 (R-22) (boiling point: -40°C)
3. Dry ice (CO_2) (boiling point: -73°C)
4. R-134a (CH_2FCF_3 , boiling point: -26°C)
5. R-410a (50% CH_2F_2 /50% CHFCF_3 , boiling point: -48°C)

(d) What is ASHRAE?

2

Answer: ASHARE means American Society of Heating, Refrigerating and Air-Conditioning Engineers.

7. (a) Derive a relation for Euler's crippling load for a column when (i) it has 8 both ends hinged (ii) both ends fixed.

Answer:

Both ends hinged:

Consider a column AB of length l hinged at both of its ends A and B and carrying a critical load at B. As a result of loading, let the column deflect into a curved form AX_1B as shown in Fig.

Now consider any section X, at a distance x from A.

Let, P = Critical load on the column, y = Deflection of the column at X.

\therefore Moment due to the critical load P , $M = -P \cdot y$

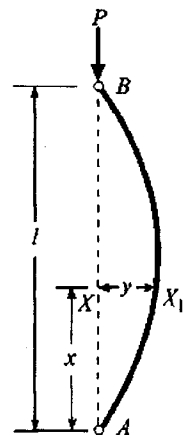
$EI \frac{d^2y}{dx^2} = -P \cdot y$.. (Minus sign due to concavity towards initial centre line)

$$EI \frac{d^2y}{dx^2} + P \cdot y = 0$$

$$\frac{d^2y}{dx^2} + \frac{P}{EI} \cdot y = 0$$

The general solution of the above differential equation is

$$Y = A \cos \left(x \sqrt{\frac{P}{EI}} \right) + B \sin \left(x \sqrt{\frac{P}{EI}} \right)$$



Where A and B are the constants of integration. We know that when $x = 0$, $y = 0$. Therefore $A = 0$. Similarly when $x = l$, then $y = 0$. Therefore

$$0 = B \sin\left(l \sqrt{\frac{P}{EI}}\right)$$

A little consideration will show that either B is equal to zero or $\sin\left(l \sqrt{\frac{P}{EI}}\right)$ is equal to zero.

Now if we consider B to be equal to zero, then it indicates that the column has not bent at all. But if $\sin\left(l \sqrt{\frac{P}{EI}}\right) = 0$

$$\therefore l \sqrt{\frac{P}{EI}} = 0 = \pi = 2\pi = 3\pi = \dots$$

Now taking the least significant value, $P = \frac{\pi^2 EI}{l^2}$

Both ends fixed:

Consider a column AB of length l fixed at both of its ends A and B and carrying a critical load at B. As a result of loading, let the column deflect as shown in Fig.

Now consider any section X at a distance x from A.

Let, P = Critical load on the column, y = Deflection of the column at X.

A little consideration will show that since both the ends of the beam AB are fixed and it is carrying a load, therefore there will be some fixed end moments at A and B.

Let, M_0 = Fixed end moments at A and B.

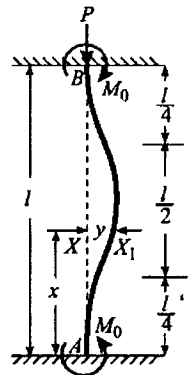
\therefore Moment due to the critical load P, $M = -P \cdot y$

$EI \frac{d^2 y}{dx^2} = M_0 - P \cdot y$.. (Minus sign due to concavity towards initial Centre line)

$$\therefore \frac{d^2 y}{dx^2} + \frac{P}{EI} \cdot y = \frac{M_0}{EI}$$

The general solution of the above differential equation is

$$Y = A \cos\left(x \sqrt{\frac{P}{EI}}\right) + B \sin\left(x \sqrt{\frac{P}{EI}}\right) + \frac{M_0}{P}$$



Where A and B are the constants of integration. We know that when $x = 0$, $y = 0$. Therefore $A = 0$. Similarly when $x = l$, then $y = 0$. Therefore $A = -\frac{M_0}{P}$. Now differentiating the above equation,

$$\frac{dy}{dx} = -A \sqrt{\frac{P}{EI}} \sin\left(x \sqrt{\frac{P}{EI}}\right) + B \sqrt{\frac{P}{EI}} \cos\left(x \sqrt{\frac{P}{EI}}\right)$$

We also know that when $x = 0$, then $\frac{dy}{dx} = 0$. Therefore,

$$0 = B \sqrt{\frac{P}{EI}}$$

A little consideration will show that either B is equal to zero or $\sqrt{\frac{P}{EI}}$ is equal to zero. Since the load P is not equal to zero, it is thus obvious that B is equal to zero. Substituting the

value $A = -\frac{M_0}{P}$ and $B=0$ in equation (i),

$$y = -\frac{M_0}{P} \cos\left(x\sqrt{\frac{P}{EI}}\right) + \frac{M_0}{P} = \frac{M_0}{P} [1 - \cos(l\sqrt{\frac{P}{EI}})]$$

We also know that when $x=l$, then $y=0$, Therefore,

$$0 = \frac{M_0}{P} [1 - \cos(l\sqrt{\frac{P}{EI}})]$$

$$\therefore \cos(l\sqrt{\frac{P}{EI}}) = 1$$

$$\therefore l\sqrt{\frac{P}{EI}} = 0 = 2\pi = 4\pi = 6\pi = \dots$$

Now taking the least significant value, $P = \frac{4\pi^2 EI}{l^2}$

(b) Explain the various ways in which riveted joint may fail.

3

Answer:

1. Tearing of the plate at an edge
2. Tearing of the plate across a row of rivets
3. Shearing of the rivets.
4. Crushing of the plate or rivets

(c) A hollow circular column of 200 mm external and 160 mm internal diameter is 5m long and fixed at both ends. It is subjected to a load of 120kN at an eccentricity of 20 mm from the axis. Find the maximum stress induced in the column. Assume $E = 120$ GPa.

Solution: Given: External diameter (D) = 200 mm; Internal diameter (d) = 160 mm; Length (l) = 5 m = 5×10^3 mm; Load (P) = 120 kN = 120×10^3 N; Eccentricity (e) = 20 mm and modulus of elasticity (E) = 120 GPa = 120×10^3 N/mm².

We know that area of the column section,

$$A = \frac{\pi}{4} [D^2 - d^2] = \frac{\pi}{4} [(200)^2 - (160)^2] = 11.31 \times 10^3 \text{ mm}^2$$

And moment of inertia of column section,

$$I = \frac{\pi}{64} [D^4 - d^4] = \frac{\pi}{64} [(200)^4 - (160)^4] = 46.37 \times 10^6 \text{ mm}^4$$

$$\therefore \text{Modulus of section, } Z = \frac{I}{D/2} = \frac{46.37 \times 10^6}{200/2} = 463.7 \times 10^3 \text{ mm}^3$$

Since the column is fixed at its both ends, therefore equivalent length of the column,

$$L_e = \frac{l}{2} = \frac{5 \times 10^3}{2} = 2.5 \times 10^3 \text{ mm}$$

$$\text{And value of } \frac{L_e}{2} \sqrt{\frac{P}{EI}} = \frac{2.5 \times 10^3}{2} \times \sqrt{\frac{120 \times 10^3}{120 \times 10^3 \times 46.37 \times 10^6}} \text{ rad} = 0.1836 \text{ rad} = 10.52^\circ$$

We know that maximum compressive stress induced in the column,

$$\sigma_{\max} = \frac{P}{A} + \frac{P \cdot e \cdot \sec \frac{L_e}{2} \sqrt{\frac{P}{EI}}}{Z} = \frac{120 \times 10^3}{11.31 \times 10^3} + \frac{120 \times 10^3 \times 20 \sec 10.52^\circ}{463.7 \times 10^3} \text{ N/mm}^2$$

$$= 10.61 + 5.26 = 15.87 \text{ N/mm}^2 = 15.87 \text{ MPa (Answer)}$$

8. (a) How to determine the maximum bending moment in a simple supporting beam? 3

Answer:

The maximum bending moment occurs in a beam, when the shear force at that section is zero.

So, to determine the maximum bending moment of a simple supported beam, moment calculate at the position of shear force is zero.

(b) Define and explain principal plane and principal stress. What are their usages? 3

Answer:

Principal Plane is that plane on which the principal stresses act and shear stress is zero.

Principal stresses are maximum and minimum value of normal stresses on a plane (when rotated through an angle) on which there is no shear stress.

(c) Derive an expression to calculate the deflection in a beam. 4

Answer: In this question there is no specific condition for the beam.

(d) A steel rod ABC is held between two rigid supports A and C as shown below. Find the stress developed in two parts of the rod when it is heated through 15K. Assume $\alpha = 12 \times 10^{-6} \text{ k}$ and $E = 200 \text{ GPa}$. 10

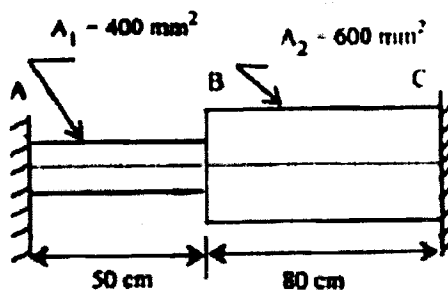


Fig. 8 (d)

Solution:

$$\delta_{AB} + \delta_{BC} = \delta_{t(AB)} + \delta_{t(BC)}$$

$$\Rightarrow \left(\frac{PL}{AE}\right)_{AB} + \left(\frac{PL}{AE}\right)_{BC} = \alpha L_{AB} \Delta T + \alpha L_{BC} \Delta T$$

$$\Rightarrow \frac{P}{200 \times 10^9} \left(\frac{0.5}{400 \times 10^{-6}} + \frac{1}{600 \times 10^{-6}} \right) = \alpha \Delta T (0.5 + 1) = 12 \times 10^{-6} \times 15 \times 1.5$$

$$\therefore P = 18514.285 \text{ N}$$

$$\sigma_{AB} = \frac{18514.285}{400 \times 10^{-6}} = 46.3 \text{ MPa (Answer)}$$

$$\sigma_{BC} = \frac{18514.285}{600 \times 10^{-6}} = 30.86 \text{ MPa (Answer)}$$

34th BCS

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MECHANICAL ENGINEERING

Subject Code:

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SECOND PAPER

Time Allowed-3 hours

Full Marks-100

[N.B.- Answer any five questions. The figures in the margin indicate full marks.]

1.(a) Name three power transmission device. Explain the suitability in different mechanism. 3

Answer:

1. Belts: Transmitting power between shafts that are widely separated or nonparallel drives.
2. Chains: It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles
3. Gears: power transmitted between two rotating shaft in shorter distance.

(b) Name six types of gear, and the way they are used. 3

Answer:

1. Spur gear
2. Helical gear
3. Bevel gear
4. Worm gear
5. Rack and pinion
6. Internal gear

(c) A rubber belt runs over a 600 mm diameter pulley at 200 rev/min. If the coefficient of friction between the pulley and the belt is 0.25 angle of lap is 160° and the maximum tension in the belt is 2.5 kN . Find the power transmitted by the belt. 6.5

Solution:

Given, $d = 600 \text{ mm} = 0.6 \text{ m}$; $N = 200 \text{ rpm}$; $\mu = 0.25$; $\theta = 160^\circ = 2.793 \text{ rad}$

$T_1 = 2.5 \text{ kN}$

We know, $v = \frac{\pi \times d \times N}{60} = 6.284 \text{ m/s}$

Let, $T_2 =$ Tension in the slack side of the belt

We know, $2.3 \log \frac{T_1}{T_2} = \mu \times \theta = 0.25 \times 2.793 = 0.6982$

$\therefore T_2 = 1.244 \text{ kN}$

We know that power transmitted by the belt,

$P = (T_1 - T_2)v = (2.5 - 1.244)284 = 7.89 \text{ kW (Answer)}$

2. (a) Why is balancing is necessary in the case of high speed engines? Explain the statement balancing of reciprocating masses are not achieved fully. 6

Answer: Balancing is very important in the case of high-speed engine. If the parts are not properly balanced, the dynamic forces are set up. These forces not only increase the loads on the bearings and stresses in the various members, but also produce unpleasant and even dangerous vibration. Thus, balancing is very important in case of high-speed engine.

Full balancing is not possible in reciprocating masses: Due to inertia of reciprocating masses, shaking force and shaking couple generate. In most cases, we can reduce the shaking force and shaking couple by adding appropriate balancing mass, but it is usually not practical to eliminate them completely. Shaking force and shaking couple always exists in the mechanism. So, balancing of reciprocating masses is not achieved fully.

(b) Explain logarithmic decrement in relation to free damped vibration with 4.5 single degree of freedom. What is critical, light and heavy damping?

Answer: The logarithmic decrement represents the rate at which the amplitude of a free damped vibration decreases. It is defined as the natural logarithm of the ratio of any two successive amplitudes.

Critical damping occurs when the system stops oscillating after the shortest possible time.

E.g. A car suspension system

Light damping occurs when the resistive forces acting are small – many oscillations occur but the time period stays constant as the amplitude falls. E.g. simple pendulum in air.

Heavy damping occurs when the resistive forces acting are large – not even one complete oscillation occurs as the system slowly returns to equilibrium. E.g. A push tap in a public toilet.

(c) Compare viscous and Cloumb damping.

2

Viscous Damping: Viscous damping is the dissipation of energy that occurs when a particle in a vibrating system is resisted by a force the magnitude of which is a constant, independent of displacement and velocity, and the direction of which is opposite to the direction of the velocity of the particle

Cloumb Damping: Coulomb damping is a type of constant mechanical damping in which energy is absorbed via sliding friction. The friction generated by the relative motion of the two surfaces that press against each other is a source of energy dissipation.

3.(a) A crank - connecting rod mechanism has a crank of length 50 mm and 8 connecting rod of length 200 mm. Find the velocity of slider attached to the end of the connecting rod. If the crank revolves at a uniform speed of 200 rev/min, when the crank will makes angle 30° with the line of stroke of the slider.

Solution:

Given, $r = 50$ mm; $l = 200$ mm; $N = 200$ rpm; $\theta = 30^\circ$

We know, $n = \frac{l}{r} = \frac{200}{50} = 4$; $\omega = \frac{2\pi \times N}{60} = 20.944$ rad/s

Velocity of slider, $v_p = \omega \times r \left(\sin \theta + \frac{\sin 2\theta}{2n} \right)$

$= 20.944 \times 0.05 \left(\sin 30^\circ + \frac{\sin 2 \times 30^\circ}{2 \times 4} \right) = 0.637$ m/s (Answer)

(b) How are internal combustion engine is classified? What are external 4.5 combustion engine? Give Example

Answer:**Classification of IC Engine:**

1. Cycle of operation: Two stroke, four stroke
 2. Thermodynamic cycle: Otto cycle, Diesel cycle, Dual fuel cycle
 3. Method of ignition: Spark ignition (SI), Compression ignition (CI)
 4. No of cylinder: Single, multi cylinder
 5. Cooling system: air cooled, water cooled, oil cooled
- External combustion engines are: coal-fired power plant, Natural gas power plant, Steam locomotive, Solar thermal power plant, Stirling engine.
- 4. (a) Spark ignition engine can not burn very lean air fuel ratio mixture but 6.5 compression ignition engine can. Discuss the statement with the reference to process of combustion in these engines.**

Answer: Gasoline (petrol) engines operate within a narrow air/fuel ratio range of approximately 12:1 to 15:1, although some modern "lean-burn" technology engines have been able to achieve significantly leaner air/fuel ratios. While the stoichiometric ratio for diesel fuel is a little lower than that for gasoline (14.6 vs. 14.7), this is not the main reason diesels are run at higher air/fuel ratios. Diesel engines can operate with a broader range than gasoline - as rich as 15:1 or as lean as 60:1, however, going richer than about 22:1 to 25:1 produces excessive temperature, soot, smoke, and poor fuel economy. This is a consequence of the fact that diesel engines are compression-ignition versus gasoline engines, which are spark-ignition. The injected fuel in a diesel engine provides a less homogeneous air-fuel mixture in the cylinder, so combustion is less uniform and a cleaner burn is achieved with a higher air/fuel ratio.

(b) Compare the real IC engine process with air standard cycles. Show the energy flow in an IC engine.

Answer:

Air standard cycle	Actual IC engine cycle
1. Pure air is used	1. Working fluid is combination of air, fuel and residual gas
2. Composition of working fluid always constant	2. Composition of working fluid changes
3. Specific heat remain constant	3. Specific heat changes

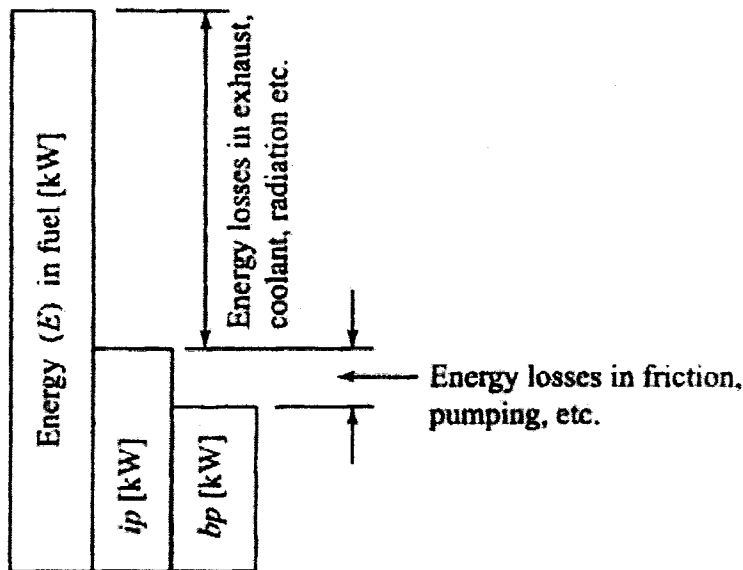


Fig: Energy flow diagram of IC engine

(c) Briefly discuss direct ignition diesel engines and indirect ignition diesel engines.

Answer: Direct injection Diesel engines inject fuel directly into the cylinder.

An indirect injection diesel engine delivers fuel into a chamber off the combustion chamber, called a prechamber, where combustion begins and then spreads into the main combustion chamber.

5. (a) Briefly discuss the prospects of renewable energy in Bangladesh.

10

Answer:

1. **Solar:** Bangladesh receives an average daily solar radiation in the range of 4.5 kWh/m²/day. According to SREDA, now Bangladesh is generating total 488.67MW electrical power from solar energy including both of the on-grid and off-grid generation. Since the introduction of Solar Home System (SHS) in 1996, it has become now the biggest renewable energy program in Bangladesh, so far installed 4.5 million units and ever increasing its number due to an integrated program undertaken by the government through its financial institution IDCOL. Dedicated funding support has also been extended through government financial institutions like Bangladesh Bank and IDCOL, as well as through private commercial banks. Moreover, government has extended fiscal incentives including duty exemption on certain renewable energy products, e.g. solar panel, solar panel manufacturing accessories, Charge Controller, Inverter, LED light, solar operated light and wind power plant.

Encouraged by the success of SHS, government has initiated number of programs like, Solar Irrigation, Solar Mini/Micro-grid, Solar Park, Solar Roof-top, Solar Boating and so on. The main focus of RE is to provide electricity to the rural areas and to reduce the dependency on diesel, so as to reduce the carbon emission.

2. **Wind power:** Bangladesh began its first wind power project in 2005. There are two wind power generation projects in Bangladesh, the Muhuri Dam wind power project and the project in Kutubdia Island. Muhuri Dam Project is the first grid-connected wind plant in Bangladesh. The estimated annual production from this 4×225 kW wind plant is about 2 GWh (for an equivalent of 2,500 hours of full load/year). Kutubdia Island is Bangladesh's other wind battery hybrid project located in Chittagong. It produces 50×20 kW with estimated annual production of 2 GWh (for an equivalent of 2,500 hours of full load/year).
3. **Biomass:** Since it is an agrarian country, biomass is one of the potential renewable energy sources in Bangladesh. Agricultural crop residues, animal manure and municipal solid waste are the major sources of biomass energy in the country. Government of Bangladesh has initiated the installation of two waste-to-energy power plants in Dhaka using daily waste produced, aiming at making it a habitable and a clean city. One of the plants will be set up at the Aminbazar landfill and the other at Matuail. One of the plants will be set up at the Aminbazar landfill and the other at Matuail.
4. **Hydro:** Bangladesh has a long legacy in the field of Renewable energy, which started back in 1957 with the start of construction of Country's first Hydroelectric project on Karnaphully river at Kaptai, Chittagong. In October 1988 the fourth and fifth generating units, both 50 MW Kaplan-type turbines, were installed which raised the total generation capacity to 230 MW.
5. **Tidal power:** Bangladesh has an extended costal area with 2-8 m tidal height ascend and descend and this height is adequate enough to generate power. Tidal energy can be simply generated from the varying sea levels, and tides are more foreseeable than wind and sunlight. Changing tidal can be used to produce electricity across a coastal bay with huge differences between low and high tides. Electricity generation from tides is very analogous to hydroelectricity generation apart from that water; which is able to run in both directions, and electricity is produced using two-way turbines. Khulna, Barisal, Bagerhat, Satkhira and Cox's Bazar regions has a low tidal height about 2-5m, whereas Sandwip has more than 5m. So, Bangladesh a good prospect of energy source of tide.

(b) Explain the terms combustion and flue gas desulfurization in reaction to coal fired power plants. 10

Answer:

Combustion: Coal is finely ground so that 70 to 80 percent by weight passes through a 200-mesh screen. The powder is burned in a combustion chamber by entraining the particles in combustion air. Because finely ground coal has more surface area per unit weight than larger particles, the combustion reactions occur at a faster rate, thus reducing the time required for complete combustion to about 1 to 2 seconds.

Flue gas desulfurization (FGD) is a control device used to remove sulfur dioxide (SO_2) from exhaust flue gases using an alkaline reagent to produce a solid compound. In this chemical reaction >90% of the sulfur dioxide (SO_2) from the flue gas can be removed and converts the limestone into calcium sulphite (CaSO_4).

6. (a) Define and explain the term : load duration curve, plant factor, load factor, diversity factor with reference to power plants. 8.5

Answer:

Load duration curve: The load duration curve is defined as the curve between the load and time in which the ordinates representing the load, plotted in the order of decreasing magnitude, i.e., with the greatest load at the left, lesser loads towards the right and the lowest loads at the time extreme right.

Plant factor:

The ratio of the average power load of an electric power plant to its rated capacity.

Load factor: Load factor is the ratio of average power generated by the plant to the maximum power that could have been generated for a given time period.

Diversity factor: Diversity factor is defined as the ratio of the sum of the maximum demands of the various part of a system to the coincident maximum demand of the whole system.

(b) Distinguish between free and forced convection heat transfer. Give examples. 4

Answer:

Items	Free convection	Forced convection
Definition	A method of heat transfer in which the motion of fluid is influenced by natural means	A method of heat transfer in which the motion of fluid is influenced by external means
Initiation of fluid motion	Fluid motion generates as a result of the change of the density of fluid when heated	Fluid motion generates as a result of an external source as pumping, fan, suction devices
Factors affecting heat transfer	No external factors affect heat transfer	Only external factor can cause heat transfer
Examples	Cooling down a boiled egg when kept in the normal air, loss of cool of a cool drink can. etc	Air conditioning, steam turbines etc

7. (a) Explain the dimensionless terms obtained for convection heat transfer and explain their correlation with each other. 6

Answer: See at chapter-4, Fundamentals of mechanical engineering vol.1

(b) What is heat transfer through a fluid conduction and when it is convection? 6.5
How does the convection heat transfer co-efficient differ from the thermal conductivity of a fluid.

Answer: Heat transfer through a fluid is conduction in the absence of bulk fluid motion, and convection in the presence of it. The rate of heat transfer is higher in convection because of fluid motion. The value of the convection heat transfer coefficient depends on the fluid motion as well as the fluid properties. Thermal conductivity is a fluid property, and its value

does not depend on the flow.

8. (a) List the main equipment that are used in air conditioning system. Mention 6 their function.

Answer: See at chapter-6, Fundamentals of mechanical engineering vol.1

(b) What are the parameters to be considered for the calculation of cooling load 6.5 for any building for summer air conditioning?

Answer:

Parameters should be considered for cooling load calculation of any building for summer air conditioning are:

(1) Internal heat load:

(a) Heat load from lighting system and equipment's

\dot{Q}_e = sum of ratings of equipments and lighting lamps

(b) Heat gain from human body: \dot{Q}_b = No. of occupants \times heat gain rate per person

(2) Wall heat load: Heat loss or gain by thermal transmission through a building wall can be calculated as

$$\dot{Q}_w = UA(\Delta T)_{wall}$$

(3) Infiltration and ventilation load:

Infiltration is defined as the uncontrolled entry of outside air directly into the conditioned space due to wind and bouncy effect arising out of temperature difference between inside and outside environments.

Ventilation is defined as the air intentionally mixed with recirculated air to meet the oxygen requirement of the occupants.

(4) Solar heat gain through glass windows and walls: The solar load can be given by the directly transmitted radiation as $Q_s(t) = A_w S(t) E$

Where, $S(t)$ is the solar heat gain coefficient function, t is the time, E is the irradiance of the direct solar beam W/m^2 , and A_w is the window area of the data center in m^2 .

9.(a) How is sand casting different from metallic mold casting process?

4

Answer:

Sand casting	Metallic mold casting
1. Sand is used to create mold	1. Metal is used to create mold
2. Moderate surface finish	2. Improved surface finish
3. Use for low and high volume production	3. Use for medium to high volume production
4. Lower cost than metal molding	4. Higher cost than sand casting

(b) Sketch a typical milling cutter tooth and name its elements. What is a fly cutter and what is its purpose?

4.5

Answer:

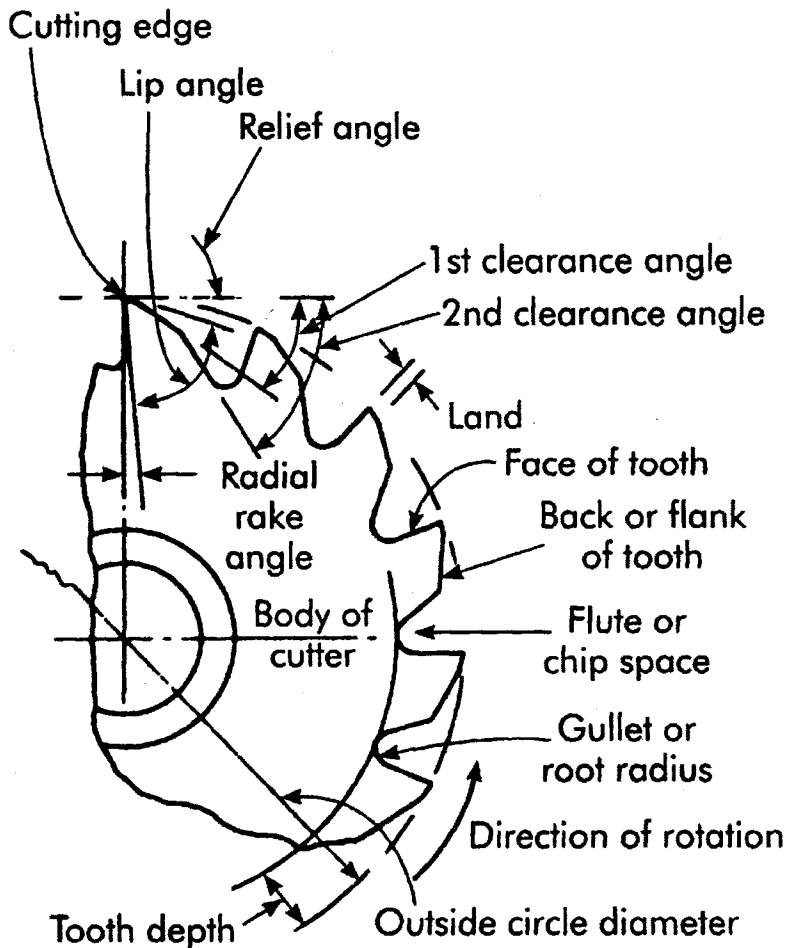


Fig: Milling cutter

Fly cutter and its use: The fly cutter is a single-point cutting tool similar to a lathe tool mounted in a special holder. Fly cutters are used primarily on a milling machine for machining large, flat surface areas.

(c) How do you relate drilling, boring and rimming?

4

Answer:

Drilling: Drilling is the process of cutting holes in a solid material using a rotating cutting tool.

Boring: boring is the process of enlarging a hole that has already been drilled.

Rimming: Rimming is the process of finishing the internal hole surface.

10. (a) Classify various manufacturing process. How is welding different from soldering and brazing?

4

Answer:

- Casting.
- Labeling and painting.
- Molding.
- Forming.
- Machining.
- Joining.

Welding: Welding is a process of joining two similar or dissimilar metals by fusion, with or without the application of pressure and with or without the use of filler metal.

Soldering: Soldering is a joining process used to join different types of metals together by melting solder. Solder is a metal alloy usually made of tin and lead which is melted using a hot iron.

Brazing: Brazing is a metal-joining process in which two or more metal items are joined together by melting and flowing a filler metal into the joint, with the filler metal having a lower melting point than the adjoining metal.

(b) What is oblique cutting? What are its purposes in metal cutting operations? 4.5

Answer:

Oblique cutting: Oblique cutting is a type of cutting in which cutting tool is at an oblique angle to the direction of tool motion. In this cutting, the flow of chip is not perpendicular to cutting edge.

Purposes of oblique cutting in metal cutting operations: Oblique cutting generates transverse cutting force which reduces tool life. Oblique cutting involves principal and auxiliary cutting edges in the cutting action which increases friction and advances wear in the cutting tool.

(c) Sketch a single point cutting tool with negative rake.

4

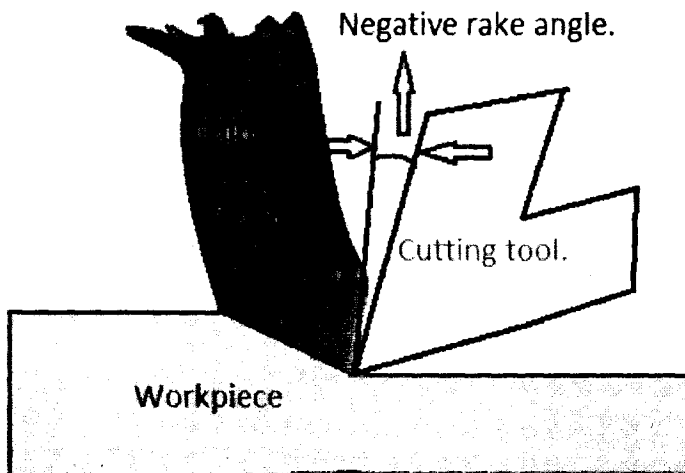


Fig: Single point cutting tool with negative rake angle

11. (a) What is work sampling? What measures can be taken to ensure 5 representative work sample in work sampling?

Answer:

Work sampling: Work sampling is the statistical technique used for determining the proportion of time spent by workers in various defined categories of activity.

A representative sample is one technique that can be used for obtaining insights and observations about a targeted population group. A representative sample is a small subset group that seeks to proportionally reflect specified characteristics exemplified in a target population.

Such samples must be representative of the chosen population studied. They must be randomly chosen, meaning that each member of the larger population has an equal chance of being chosen. They must be large enough so as not to skew the results.

(b) What is a control chart? How is the lack of a control indicated on a control 5 chart?

Answer: Control chart: The control chart is a graph used to study how a process changes over time. Data are plotted in time order. A control chart always has a central line for the average, an upper line for the upper control limit, and a lower line for the lower control limit. These lines are determined from historical data.

The lack of a control is indicated on a control chart by -

1. A lack of control is indicated whenever a single point falls outside the three-sigma control limits.
2. A lack of control is indicated whenever at least two out of three successive values fall on the same side of, and more than two sigma units away from, the central line.
3. A lack of control is indicated whenever at least four out of five successive values fall on the same side of, and more than one sigma unit away from, the central line.
4. A lack of control is indicated whenever at least eight successive values fall on the same side of the central line.

Rules one and four are the first tests to run because they are easy. Rule 2 and 3 can be used when earlier detection is needed. These rules are designed to detect sustained shifts. Other run tests should be used to detect oscillation and changes in trends.

(c) What is measurement? Discuss the application of measurement system. 2.5

Answer:

Measurement: Measurement is the numerical quantification of the attributes of an object or event, which can be used to compare with other objects or events.

Applications of measurement system:

1. Monitoring of process and operation- simply indicating the value or condition of the parameter under study.
2. Control of process and operations- automatic control system a very strong association between measurement and control.
3. Experimental engineering analysis- engineering problems, theoretical and experimental

methods may be used depending upon the nature of the problem.

12. (a) Describe the process of management and explain how it can be used to 6.5 accomplish results in any organizations.

Answer: Management process: Management process is a process of setting goals, planning and/or controlling the organizing and leading the execution of any type of activity.

Steps are:

Planning, it determines the objectives, evaluate the different alternatives and choose the best

Organizing, define the group's functions, establish relationships and defining authority and responsibility

Staffing, recruitment or placement and selection or training takes place for the development of members in the firm

Directing, is to give the Direction to the employees

Management in any organization:

1. **It helps in Achieving Group Goals** - It arranges the factors of production, assembles and organizes the resources, integrates the resources in effective manner to achieve goals. It directs group efforts towards achievement of pre-determined goals. By defining objective of organization clearly there would be no wastage of time, money and effort. Management converts disorganized resources of men, machines, money etc. into useful enterprise. These resources are coordinated, directed and controlled in such a manner that enterprise work towards attainment of goals.
2. **Optimum Utilization of Resources** - Management utilizes all the physical & human resources productively. This leads to efficacy in management. Management provides maximum utilization of scarce resources by selecting its best possible alternate use in industry from out of various uses. It makes use of experts, professional and these services leads to use of their skills, knowledge, and proper utilization and avoids wastage. If employees and machines are producing its maximum there is no under employment of any resources.
3. **Reduces Costs** - It gets maximum results through minimum input by proper planning and by using minimum input & getting maximum output. Management uses physical, human and financial resources in such a manner which results in best combination. This helps in cost reduction.
4. **Establishes Sound Organization** - No overlapping of efforts (smooth and coordinated functions). To establish sound organizational structure is one of the objectives of management which is in tune with objective of organization and for fulfillment of this, it establishes effective authority & responsibility relationship i.e., who is accountable to

whom, who can give instructions to whom, who are superiors & who are subordinates. Management fills up various positions with right persons, having right skills, training and qualification. All jobs should be cleared to everyone.

5. **Establishes Equilibrium** - It enables the organization to survive in changing environment. It keeps in touch with the changing environment. With the change in external environment, the initial co-ordination of organization must be changed. So, it adapts organization to changing demand of market / changing needs of societies. It is responsible for growth and survival of organization.
6. **Essentials for Prosperity of Society** - Efficient management leads to better economical production which helps in turn to increase the welfare of people. Good management makes a difficult task easier by avoiding wastage of scarce resource. It improves standard of living. It increases the profit which is beneficial to business and society will get maximum output at minimum cost by creating employment opportunities which generate income in hands. Organization comes with new products and researches beneficial for society.

(b) What are the salient features of project structures of organization? For what kind of organizations is it more suitable? What are its limitations? 6

Answer: Project structure results from the horizontal grouping of a number of functions for creating teams to handle specific tasks, or achieve goals.

Its greatest advantage is its flexibility and responsiveness to innovative ideas. It is especially suited where unique solutions are needed to cope with changing environments.

Project organization structures are most suitable when:

1. The undertaking or activity is definable in terms of specific goals.
2. It has a definite completion time schedule and specific cost and quality requirements.
3. It is in some way unique or unfamiliar to organization.
4. Its completion requires coordination of a number of specialized skills.
5. It is of a temporary nature.

Limitations: The major handicap of project structure is that it often creates a situation of conflict of authority between the project manager and corporate functional heads. Project managers have also been found to incertain considerable anxiety about their career progress.

35th BCS

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September

Subject Code: 901

Time Allowed—4 hours

Full Marks—200

*[N.B. – (i) Answer any 10(ten) questions.**(ii) Figures in the right margin indicate full marks.**(iii) Symbols have their usual meanings.**(iv) Assume any reasonable data/assumptions, if required.]*

Marks

2.5×

8=20

1. Define (any eight)**(i) Boiler efficiency;****(ii) Ton of refrigeration;****(iii) Specific speed of a water turbine;****(iv) Pitch and lead of a screw thread;****(v) Convective heat transfer coefficient;****(vi) Octane number of a fuel;****(vii) Brake thermal efficiency of an engine;****(viii) Signal conditioning of a measurement system;****(ix) Operational amplifier;****(x) HCCI engine;****(i) Boiler efficiency:**

It may be defined as the ratio of heat actually used in producing the steam to the heat liberated in the furnace. It is also known as the thermal efficiency of the boiler.

$$\eta = \frac{\text{Heat actually used in producing steam}}{\text{Heat liberated in furnace}} = \frac{m_e(h - h_{f1})}{C}$$

Where,

 m_e = mass of water actually evaporated in kg/kg of fuel C = Calorific value of the fuel kJ/kg

$$m_e = \frac{m_s}{m_f}$$

 m_s = total mass of water evaporated in steam m_f = mass of fuel used in kg**(ii) Ton of refrigeration: “Fundamentals of Mechanical Engineering vol.1 chapter-6”**

(iii). Specific speed of a water turbine: It is defined as the speed of a turbine which is identical in shape, geometrical dimensions, blade angles, gate opening etc. with a actual turbine but of such a size that it will develop unit power working under unit head.

$$N_s = \frac{N\sqrt{P}}{H^{5/4}}$$

Where, N_s = specific speed of the turbine N = speed of actual turbine H = head under the turbine is working P = power developed or shaft power

(iv) Pitch and lead of a screw thread: Pitch is the distance between screw threads and is commonly used with inch sized products and specified as threads per inch.

Lead: The lead for a screw thread is the axial travel for a single revolution.

(v) Convective heat transfer coefficient: The convection heat transfer coefficient in thermodynamics is the proportionally constant between the heat flux and the thermodynamic driving force ΔT .

$$h = \frac{Q}{A \cdot \Delta T} \text{ W/m}^2\text{K}$$

(vi) Octane number of a fuel: Octane number, also called Antiknock Rating, measure of the ability of a fuel to resist knocking when ignited in a mixture with air in the cylinder of an internal combustion engine. The octane number is the percentage by volume of iso-octane in the iso-octane–heptane mixture that matches the fuel being tested in a standard test engine.

(vii) Brake thermal efficiency of an engine:

It is the ratio of the heat equivalent to one kW hour to the heat in fuel per B.P hour. It is also known as overall thermal efficiency of the engine.

$$\eta_b = \frac{\text{Heat equivalent to one kW hour}}{\text{Heat in fuel per B. P hour}}$$

(viii) Signal conditioning of a measurement system: Signal conditioning is the technique of making a signal from a sensor or transducer suitable for processing by data acquisition equipment.

(ix) Operational amplifier: An operational amplifier (often op-amp) is a DC coupled high-gain electronic voltage amplifier with a differential input and, usually, a single ended output.

(x) HCCI engine:

Homogeneous Charge Compression Ignition (HCCI) is a form of internal combustion in which well-mixed fuel and oxidizer (typically air) are compressed to the point of auto-ignition. As in other forms of combustion, this exothermic reaction releases energy that can be transformed in an engine into work and heat.

2. (a) Classify steam boilers. Distinguish between a water tube boiler and a fire tube boiler.

7

There are a large number of boiler designs, but they may be classified according to the following criteria:

1. According to relative passage of water and hot gases:
 - (a) Water tube boiler
 - (b) Fire tube boiler
2. According to water circulation arrangement:
 - (c) Natural circulation
 - (d) Forced circulation
3. According to use:
 - (e) Stationary boiler
 - (f) Portable boiler
 - (g) Locomotive

- (h) Marine boiler
- 4. According to position of the furnace:
 - (c) Internally fired
 - (d) Externally fired
- 5. According to pressure of steam generated
 - (f) Low pressure boiler
 - (g) Medium pressure boiler
 - (h) High pressure boiler
 - (i) Sub-critical boiler
 - (j) Super-critical-boiler
- 6. According to the position of the Boiler: Horizontal, inclined or vertical
- 7. According to the charge in the furnace:
 - (e) Pulverized fuel
 - (f) Supercharged fuel
 - (g) Fluidized bed combustion boilers

Fire tube boiler	Water tube boiler
1. The hot flue gases pass through tubes and water surrounds them	1. Water passes through tubes and hot flue gases surrounds them
2. These are operated at low pressure up to 20 bar	2. The working pressure is high enough, up to 250 bar in supercritical boilers
3. The rate of steam generation and quality of steam is low	3. The rate of steam generation and quality of steam is better
4. Load fluctuations cannot be handled	4. Load fluctuation can easily be handled
5. It requires more floor area	5. It requires less floor area
6. Overall efficiency is up to 75%	6. Overall efficiency up to 90%
7. Water does not circulate in a definite direction	7. Direction of water circulation is well defined
8. Use in process industry	8. Use in large power plant

(b) Give 5 examples of boiler mountings and examples of boiler accessories.

5

Answer: Fundamentals of mechanical engineering vol.1-chapter-1

(c) What are the functions of a superheater? Briefly explain the working principle of a boiler economizer.

8

Answer:

Superheater: It is a heat exchanger in which products of heat of combustion are utilized to dry the wet steam and to make it superheated by increasing its temperature. During superheating of the steam, pressure remains constant and its volume and temperature increase.

Economizer: An economizer is a heat exchanger used for heating the feed water before it

enters the boiler. The economizer recovers some of waste heat of hot flue gases going to the chimney thus it helps in improving the boiler efficiency. It is placed in the path of flue gases at the rear end of the boiler just before the air preheater.

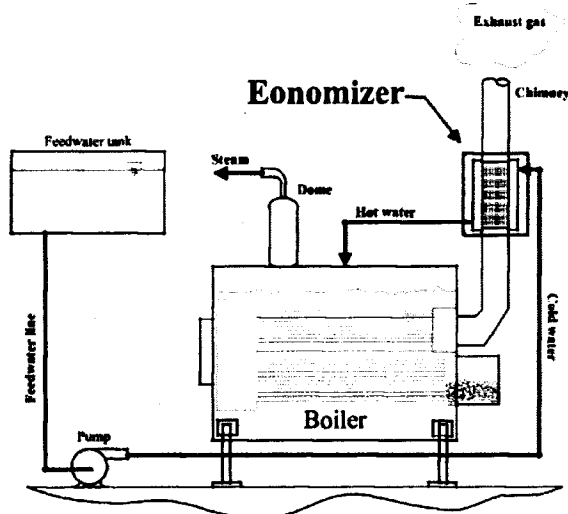
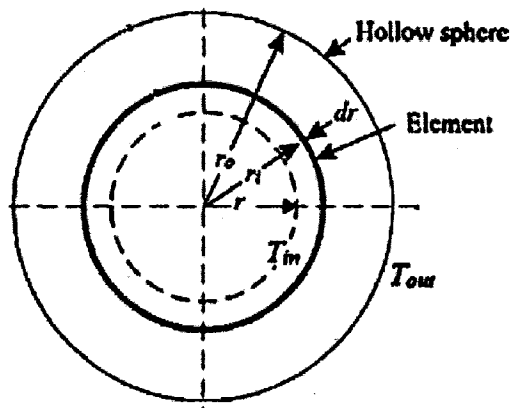


Fig: Boiler with economizer

3. (a) What is meant by thermal resistance? Derive an expression for the thermal resistance through a hollow spherical shell of inside radius r_i and outside radius r_o having a thermal conductivity K .

Thermal resistance: Thermal resistance is a heat property and a measurement of a temperature difference by which an object or material resists a heat flow. Thermal resistance is the reciprocal of thermal conductance.

Expression of thermal resistance:



Let us consider a hollow sphere as shown above.

T_{in} = Inside temperature.

T_{out} = Outside temperature.

r_i = Inside radius.

r_o = Outside radius.

k = Thermal conductivity

We know;

$$q = -kA \frac{dT}{dr}$$

$$q = -k(4\pi r^2) \frac{dT}{dr}$$

$$\frac{dr}{r^2} = -\frac{4\pi k dT}{q}$$

$$\int_{r_i}^{r_o} \frac{dr}{r^2} = -\frac{4\pi k}{q} \int_{T_{in}}^{T_{out}} dT$$

$$\left[-\frac{1}{r}\right]_{r_i}^{r_o} = -\frac{4\pi k}{q} [T_{out} - T_{in}]$$

$$\left[\frac{1}{r_i} - \frac{1}{r_o}\right] = \frac{4\pi k}{q} (T_{in} - T_{out})$$

$$\frac{r_o - r_i}{r_o r_i} = \frac{4\pi k (T_{in} - T_{out})}{q}$$

$$q = \frac{(T_{in} - T_{out})}{\frac{r_o - r_i}{4\pi k r_i r_o}}$$

\therefore The expression for thermal resistance of hollow spherical shell, $R = \frac{r_o - r_i}{4\pi k r_i r_o}$

(b) A steel ball [$c = 0.461 \text{ J/kg-K}$, $K = 35 \text{ W/m K}$] 5.0 cm in diameter and initially at a uniform temperature of 450°C is suddenly placed in a controlled environment in which the temperature is maintained at 100°C . The convective heat transfer coefficient is $10 \text{ W/m}^2\text{K}$. Calculate the time required for the ball to attain a temperature of 150°C . 7

Solution: Given, $c_p = 0.461 \text{ J/kg-K}$; $k = 35 \text{ W/m K}$ and $h = 10 \text{ W/m}^2\text{K}$

$$\text{Characteristics length, } L_c = \frac{V}{A_c} = \frac{\frac{4}{3}\pi r^3}{4\pi r^2} = \frac{\frac{4}{3}\pi \times 0.025^3}{4\pi \times 0.025^2} = 0.00833 \text{ m}$$

$$\therefore \text{Biot number} = \frac{hL_c}{k} = \frac{10 \times 0.00833}{35} = 0.00238 \text{ so the lumped system is applicable.}$$

We know;

$$b = \frac{hA}{\rho V c_p} = \frac{10 \times 4\pi \times 0.025^2}{7860 \times \frac{4\pi \times 0.025^3}{3} \times 0.461} = 0.3312 \text{ s}^{-1} \quad [\text{let density of steel ball} = 7860 \text{ kg/m}^3]$$

$$\frac{T(t) - T(\infty)}{T(i) - T(\infty)} = e^{-bt}$$

$$\Rightarrow \frac{(150+273) - (100+273)}{(450+273) - (100+273)} = e^{-0.3312t}$$

$$\therefore t = 5.87 \text{ sec (Answer)}$$

(c) Calculate the net radiant interchange per unit area for two large planes at

temperature 540°C and 315°C respectively. Assume that, the emissivity of the hot and cold plates are 0.9 and 0.7 respectively. 5

Solution:

Given; $T_1 = (540 + 273)\text{K} = 813\text{K}$; $T_2 = (315 + 273)\text{K} = 588\text{K}$;

$\epsilon_1 = 0.9$ and $\epsilon_2 = 0.7$

We know, Stefan Boltzmann constant $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2 \text{ K}^4$

$$\begin{aligned} \text{So net radiant per unit area, } q &= \frac{\sigma(T_1^4 - T_2^4)}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1} \\ &= \frac{5.67 \times 10^{-8} (813^4 - 588^4)}{\frac{1}{0.9} + \frac{1}{0.7} - 1} = 11686 \text{ W/m}^2 \text{ (Answer)} \end{aligned}$$

4.(a) A reservoir 100m long and 100m wide is provided with a rectangular notch 2m long. Find the time required to lower the water level in the reservoir from 2m to 1m in $C_d = 0.6$. 10

Solution: Area of reservoir $A = 100 \times 100 = 10000\text{m}^2$

Length of notch $L = 2\text{m}$

Initial height of water $H_1 = 2\text{m}$

Final height of water $H_2 = 1\text{m}$

Co-efficient of discharge $C_d = 0.6$

$$\begin{aligned} \text{Required time, } T &= \frac{3A}{C_d \times L \times \sqrt{(2g)}} \left[\frac{1}{\sqrt{H_2}} - \frac{1}{\sqrt{H_1}} \right] \\ &= \frac{3 \times 10000}{0.6 \times 2 \times \sqrt{(2 \times 9.81)}} \left[\frac{1}{\sqrt{1}} - \frac{1}{\sqrt{2}} \right] \\ &= 1653 \text{ sec} = 27.55 \text{ min (Answer)} \end{aligned}$$

(b) Two reservoirs are connected by three pipes laid in parallel. Their diameters are d , $2d$ and $3d$ respectively. What will be the discharge through each of larger pipes, if the smallest pipe is discharging $1\text{m}^3/\text{s}$? 10

Solution:

Assume; the length of three pipes and friction co-efficient of three pipes are same.

For parallel pipes head loss due to friction is constant. So head loss is given by;

$$h_f = \frac{4fLv_1^2}{2gd} = \frac{4fLv_2^2}{2g(2d)} = \frac{4fLv_3^2}{2g(3d)} \text{ where } v_1, v_2 \text{ and } v_3 \text{ are velocity in pipe1, pipe2 and pipe3}$$

$$\therefore \frac{v_2^2}{v_1^2} = 2 \text{ and } \frac{v_3^2}{v_1^2} = 3$$

$$\begin{aligned} Q_1 &= \text{discharge through the pipe of diameter } d \text{ (pipe1).} \\ &= 1 \text{ m}^3/\text{s (given)} \end{aligned}$$

Let, $Q_2 =$ discharge through the pipe of diameter $2d$ (pipe2).

$Q_3 =$ discharge through the pipe of diameter $3d$ (pipe3).

$A_1 =$ Cross-sectional area of pipe of diameter d .

$$= \frac{\pi d^2}{4} \text{ m}^2$$

$A_2 =$ Cross-sectional area of pipe of diameter $2d$.

$$= \frac{\pi (2d)^2}{4} \text{ m}^2$$

$A_3 =$ Cross-sectional area of pipe of diameter $3d$.

$$= \frac{\pi(3d)^2}{4} m^2$$

So from continuity equation;

$$Q_1 = A_1 v_1 \quad \text{and} \quad Q_2 = A_2 v_2 \quad \text{and} \quad Q_3 = A_3 v_3$$

$$\frac{Q_2}{Q_1} = \frac{A_2 v_2}{A_1 v_1} = \frac{\frac{\pi(2d)^2}{4} \times v_2}{\frac{\pi d^2}{4} \times v_1} = \frac{4d^2}{d^2} \times \frac{v_2}{v_1} = 4 \times \sqrt{2} \left[\text{since } \frac{v_2^2}{v_1^2} = 2 \right]$$

$$\therefore Q_2 = 4 \times \sqrt{2} \times Q_1 = 5.66 \text{ m}^3/\text{s} \text{ (Answer)}$$

Similarly,

$$\frac{Q_3}{Q_1} = \frac{A_3 v_3}{A_1 v_1} = \frac{\frac{\pi(3d)^2}{4} \times v_3}{\frac{\pi d^2}{4} \times v_1} = \frac{9d^2}{d^2} \times \frac{v_3}{v_1} = 9 \times \sqrt{3} \left[\text{since } \frac{v_3^2}{v_1^2} = 3 \right]$$

$$\therefore Q_3 = 9 \times \sqrt{3} \times Q_1 = 15.58 \text{ m}^3/\text{s} \text{ (Answer)}$$

5. (a) Distinguish between a pump and a water turbine.

5

Answer:

Pump	Turbine
1. Input is mechanical energy	1. Input is hydraulic energy
2. Output is hydraulic energy	2. Output is mechanical energy
3. Total dynamic head to be generated by pump increases with increasing flow	3. Available head decreases with increasing flow
4. Impeller rotates to the opposite direction of turbine runner	4. Runner rotates to the opposite direction of pump impeller
5. Positive displacement pump, centrifugal pump	5. Impulse and reaction turbine

(b) Distinguish between an impulse and a reaction turbine.

5

Answer:

Impulse Turbine	Reaction Turbine
1. Pressure drops takes place in nozzle only and pressure remains constant in moving blades.	1. Pressure drop takes place in both fixed blades and moving blades. Thus, pressure values is different on the two sides of the moving blades.

2. Blade shape is profile type and its manufacturing cost is simple.	2. Blade shape is aero foil type and its manufacturing is difficult.
3. Blade passage is of constant cross-sectional area since there is no expansion.	3. Blade passage is of variable cross-sectional area due to expansion.
4. Because of large pressure drop in nozzle, the numbers of stages are less.	4. Because of small pressure drop in each stage, the numbers of stage are larger for same pressure drop.
5. Because of large pressure drop, the blade speed and steam speed are larger.	5. Because of small pressure drop, the blade speed and steam speed are small.
6. Overall friction losses are more compared to leakage losses.	6. Leakage losses are more compared to friction loss.
7. Occupies less space per unit power.	7. Occupies more space per unit power.
8. Suitable for small power.	8. Suitable for medium and large power.

(c) A Pelton wheel has a mean bucket speed of 12m/s and is supplied with water at the rate of 750 liters/s under a head of 35m. If the bucket deflect the jet through an angle of 160° , find the power and efficiency of the turbine. Take the coefficient of velocity as 0.98.

10

Solution: Given, $U = 12 \text{ m/s}$; $Q = 750 \times 10^{-3} \text{ m}^3/\text{s}$; $H = 35 \text{ m}$;

$\phi = 180 - 160 = 20^\circ$; $C_v = 0.98$

We know, For Pelton wheel,

$$\begin{aligned} \text{Work done per unit mass} &= \frac{(UV_1 - U^2)(1 + \cos \phi)}{g} \\ &= \frac{(12 \times 25.68 - 12^2)(1 + \cos 20^\circ)}{9.81}; [V_1 = 0.98\sqrt{2gH} = 25.68 \text{ m/s}] \\ &= 32.46 \text{ J/kg} \end{aligned}$$

$$\therefore \text{Power} = \gamma \times Q (\text{Work done per unit mass})$$

$$= 1000 \times 9.81 \times 0.75 \times 32.46$$

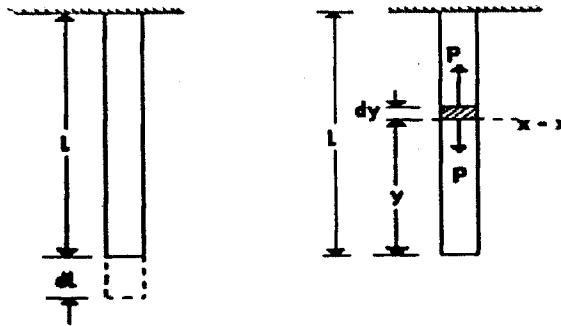
$$= 238824.45 \text{ W or } 238 \text{ kW (Answer)}$$

$$\therefore \eta = \frac{\text{work done per unit mass}}{\text{Head}} = \frac{32.46}{35} = 92.7\% \cong 93\% \text{ (Answer)}$$

6. (a) Derive, from fundamental, the relation for deformation of a body when it is subjected to its own weight.

6

Consider a bar of circular cross section and uniform diameter throughout. Consider it to be suspended from a rigid support and its top end, such that it is in a hanging in a vertical position as shown in the figure.



Let,

A = Uniform cross sectional area of the bar

E = Young's modulus for the bar

L = Length of the bar

ρ = Weight of the bar, per unit length, for the material of the bar

Consider an element of length 'dy' at a distance of 'y' from the bottom of the bar being elongated due to the force 'P', at section x-x, as shown in the figure.

Weight of portion below x-x = $P = \rho \times A \times y$

$$\text{Change in length of the element } dy = \frac{Pl}{AE} = \frac{\rho \times A \times y \times dy}{AE} = \frac{\rho \times y \times dy}{E}$$

For total change in the length of the bar, we need to integrate along the length

$$\text{Total change in length} = \int_0^L \frac{\rho y dy}{E}$$

On integrating, we get,

$$\delta L = \frac{\rho L^2}{2E}$$

This is the expression for the elongation of a uniform bar under self-weight.

(b) A steel rod ABC is firmly held between two rigid support A and C as shown 10
is Fig. 6(b) :-

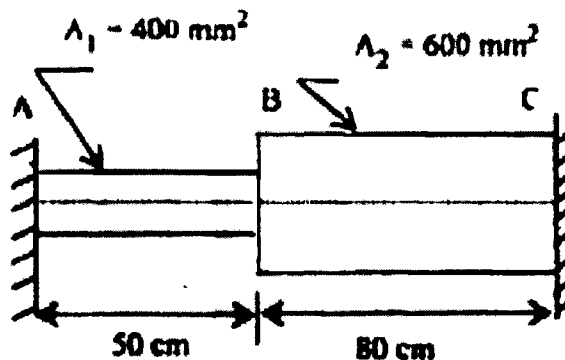


Fig. 6 (b)

Find the stress developed in the two portions of the rod where it is heated through 15K. Take $\alpha = 12 \times 10^{-6}/K$ and $E = 200 \text{ GPa}$.

Solution: Given,

$$A_1 = 400 \text{ mm}^2 \quad l_1 = 50 \text{ cm}$$

$$A_2 = 600 \text{ mm}^2 \quad l_2 = 80 \text{ cm}$$

$$\Delta T = 15 \text{ K}$$

$$\alpha = 12 \times 10^{-6} / \text{K}$$

$$E = 200 \text{ GPa}$$

As the two end is fixed

$$(\delta_T)_1 + (\delta_T)_2 = (\delta_P)_1 + (\delta_P)_2$$

$$\Rightarrow (\alpha L_1 \Delta T)_1 + (\alpha L_2 \Delta T)_2 = P \left(\frac{L_1}{A_1 E} + \frac{L_2}{A_2 E} \right)$$

$$\Rightarrow 12 \times 10^{-6} \times 15 (0.5 + 0.8) = P \left(\frac{0.5}{400 \times 10^3 \times 200} + \frac{0.8}{600 \times 10^3 \times 200} \right)$$

$$\Rightarrow P = 18116.13 \text{ N}$$

$$\sigma_1 = \frac{P}{A_1} = \frac{18116.13}{400 \times 10^{-6}} = 45290325 \text{ N/m}^2 \text{ (Answer)}$$

$$\sigma_2 = \frac{P}{A_2} = \frac{18116.13}{600 \times 10^{-6}} = 30193550 \text{ N/m}^2 \text{ (Answer)}$$

(c) Distinguish between circumferential stress and longitudinal stress in a cylindrical shell when subjected to an internal pressure. 4

Circumferential stress	Longitudinal stress
Acts tangent to the surface of cylinder.	Acts parallel to the longitudinal axis of cylinder.
$\sigma_t = \frac{pD}{2t}$	$\sigma_t = \frac{pD}{4t}$

7. (a) What are the basic laws of thermodynamics? What are the limitations of first law? 10

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Limitations of First Law of Thermodynamics

- The limitation of the first law of thermodynamics is that it does not say anything about the direction of flow of heat.
- It does not say anything whether the process is a spontaneous process or not.
- The reverse process is not possible. In actual practice, the heat doesn't convert completely into work. If it would have been possible to convert the whole heat into work, then we could drive ships across the ocean by extracting heat from the water of the ocean.

(b) An engine works between the temperature limits of 1000°C and 0°C . What can be the maximum thermal efficiency of the engine? 5

Solution: $T_h = 1000^\circ\text{C} = 1000 + 273 \text{ K} = 1273 \text{ K}$ and $T_c = 0^\circ\text{C} = 0 + 273 \text{ K} = 273 \text{ K}$

$$\eta = \frac{T_h - T_c}{T_h} = \frac{1273 - 273}{1273} = 0.786 = 78.6 \% \text{ (Answer)}$$

(c) 0.1 m^3 of air at a pressure of 1.5 bar is expanded isothermally to 0.5 m^3 . Calculate the final pressure and heat supplied during the process. 5

$$V_1 = 0.1 \text{ m}^3 \quad V_2 = 0.5 \text{ m}^3$$

$$P_1 = 1.5 \text{ bar} \quad P_2 = ?$$

Heat supplied, $Q = ?$

For isothermal process,

$$\frac{P_1}{P_2} = \frac{V_2}{V_1}$$

$$\begin{aligned} P_2 &= P_1 \times \frac{V_1}{V_2} \\ &= 1.5 \times \frac{0.1}{0.5} \\ &= 0.3 \text{ bar} \end{aligned}$$

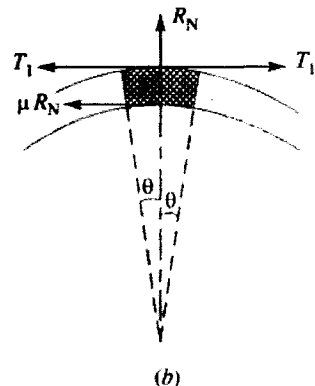
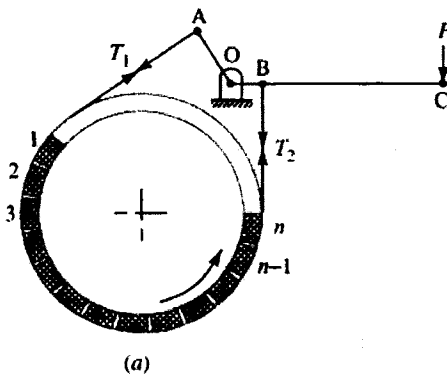
$$\text{Heat supplied during the process, } Q = 2.3 \times P_1 \times V_1 \times \log \frac{V_2}{V_1}$$

$$\begin{aligned} \Rightarrow Q &= 2.3 \times 1.5 \times 105 \times 0.1 \times \log \frac{0.5}{0.1} \\ &= 24114.46 \text{ J} = 24.114 \text{ KJ (Answer)} \end{aligned}$$

8.(a) Show that, in a band and block brake the ratio of maximum and minimum tensions in the brake straps is: $\frac{T_{\max}}{T_{\min}} = \left(\frac{1 + \mu \tan \theta}{1 - \mu \tan \theta} \right)^n$

8

Answer:



The band brake may be lined with blocks of wood or other material, as shown in Fig. (a). The friction between the blocks and the drum provides braking action. Let there are 'n' number of blocks, each subtending an angle 2θ at the centre and the drum rotates in anticlockwise direction.

Let T_1 = Tension in the tight side,

T_2 = Tension in the slack side,

μ = Coefficient of friction between the blocks and drum,

T_1' = Tension in the band between the first and second block,

T_2', T_3' etc. = Tensions in the band between the second and third block, between the third and fourth block etc.

Consider one of the blocks (say first block) as shown in Fig. (b). This is in equilibrium under the action of the following forces :

1. Tension in the tight side (T_1),
2. Tension in the slack side (T_1') or tension in the band between the first and second block,
3. Normal reaction of the drum on the block (R_N), and

4. The force of friction ($\mu.R_N$).

Resolving the forces radially, we have $(T_1 + T_1') \sin\theta = R_N \dots \dots \dots$ (i)

Resolving the forces tangentially, we have $(T_1 - T_1') \cos\theta = \mu R_N \dots \dots \dots$ (ii)

Dividing equation (ii) by (i), we have

$$\frac{(T_1 - T_1') \cos\theta}{(T_1 + T_1') \sin\theta} = \frac{\mu R_N}{R_N}$$

$$\Rightarrow (T_1 - T_1') = \mu \tan\theta (T_1 + T_1')$$

$$\Rightarrow \frac{T_1}{T_1'} = \frac{1 + \mu \tan\theta}{1 - \mu \tan\theta}$$

Similarly it can be proved for each of the blocks that

$$\frac{T_1'}{T_2'} = \frac{T_2'}{T_3'} = \frac{T_3'}{T_4'} = \dots \dots \dots = \frac{T_{n-1}}{T_2} = \frac{1 + \mu \tan\theta}{1 - \mu \tan\theta}$$

$$\therefore \frac{T_1}{T_2} = \frac{T_1}{T_1'} \times \frac{T_1'}{T_2'} \times \frac{T_2'}{T_3'} \times \dots \times \frac{T_{n-1}}{T_2} = \left(\frac{1 + \mu \tan\theta}{1 - \mu \tan\theta} \right)^n \text{ (Shown)}$$

(b) Explain briefly the differences among simple, compound and epicyclic gear trains. What are the special advantages of epicyclic gear train?

7

Simple gear train	Compound gear train	Epicyclic gear train
Only one gear in each shaft and there is a relative motion between shaft axis.	There is more than one gear on the shaft which is rigidly fixed and meshed with the gear on another shaft forming gear train.	The axis of shaft on which the gear are mounted may move relative to the fixed axis
For large speed reduction, large size of gear is required.	For large speed reduction the small gear ratio is required.	For large speed reduction in high velocity moderate size gear is required.

Special advantages of epicyclic gear train:

1. Coaxial arrangement of input shaft and output shaft
2. Load distribution to several planetary gears
3. High efficiency due to low rolling power
4. Almost unlimited transmission ratio options due to combination of several planet stages
5. Suitable as planetary switching gear due to fixing this or that part of the gearbox
6. Possibility of use as overriding gearbox
7. Favorable volume output
8. Suitability for a wide range of applications

(c) Find the power transmitted by a belt over a pulley of 60cm diameter at 200 rpm. The coefficient of friction between the belt and the pulley is 0.25, angle of lap 160° and maximum tension in the belt is 2500N.

5

Solution: Given: Diameter of pulley, $D = 60\text{cm} = 0.6\text{m}$

Speed of pulley, $N = 200\text{ rpm}$

Friction co-efficient, $\mu = 0.25$

Contact angle, $\theta = \frac{160\pi}{180} = 2.793\text{ rad}$

Tension on tight side, $T_1 = 2500\text{N}$

Tension on slack side = T_2

We know;

$$\text{velocity of belt, } V = \frac{\pi DN}{60} = \frac{3.1416 \times 0.6 \times 200}{60} = 6.2832 \text{ m/s}$$

we also know,

$$\frac{T_1}{T_2} = e^{\mu\theta}$$

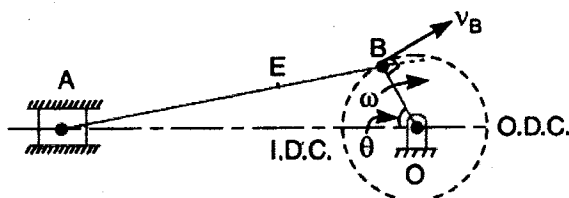
$$\frac{T_1}{T_2} = e^{(0.25 \times 2.793)} = 2.01$$

$$T_2 = \frac{T_1}{2.01} = \frac{2500}{2.01} = 1243.78 \text{ N}$$

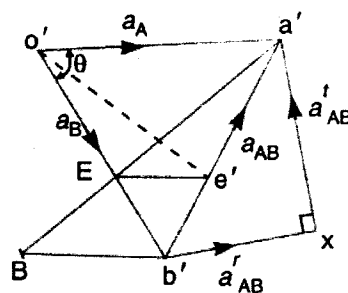
$$\therefore \text{Power transmitted by belt } P = (T_1 - T_2)V = (2500 - 1243.78) \times 6.2832 = 7893 \text{ watt (Answer)}$$

9.(a) Draw the acceleration diagram of a slider-crank mechanism.

5



(a) Slider crank mechanism.



(b) Acceleration diagram.

(b) Explain clearly the terms 'static balancing' and 'dynamic balancing'. Explain the necessary conditions to achieve them. 6

Static balancing: This process is utilized to balance systems that have stationary components with an overall center of gravity on the axis of rotation. With a static balance correctly calibrated, an object can remain perfectly balanced even while motion occurs, such as the switching of positions of a machine component.

Necessary condition:

This condition is attained when the sum of the centrifugal forces on the rotating mass due to unbalanced masses is zero in any radial direction. Or i) Static balancing is a balance of forces due to action of gravity. ii) A body is said to be in static balance when its center of gravity is in the axis of rotation.

Dynamic balancing: When a component or assembly does not create centrifugal force with rotation, it's dynamically balanced. An imbalance in rotation creates exponentially growing centrifugal force that pushes a system more and more off balance, quickly leading to a failure or breakdown. Balancing with counterweights that are precisely calibrated allows a rotation to remain dynamically balanced indefinitely if no other external forces are applied.

Necessary condition:

- i) The net dynamic force acting on the shaft is equal to zero.
 ii) The net couple due to dynamic forces acting on the shaft is equal to zero.

(c) Four masses 200 kg, 300 kg, 240kg and 260 kg are rotating in the same plane of a shaft. The corresponding radii of rotation are 0.2m, 0.15m, 0.25m and 0.3m respectively and angles between successive masses are 45° , 75° and 135° . Find the position and magnitudes of the balance mass required if its radius of rotation is 0.2m. 9

Solution:

Given; $\theta_1 = 0^\circ$; $\theta_2 = 45^\circ$; $\theta_3 = 45^\circ + 75^\circ = 120^\circ$; $\theta_4 = 45^\circ + 75^\circ + 135^\circ = 255^\circ$

$m_1 = 200$ kg; $m_2 = 300$ kg; $m_3 = 240$ kg; $m_4 = 260$ kg; $r_1 = 0.2$ m; $r_2 = 0.15$ m

$r_3 = 0.25$ m; $r_4 = 0.3$ m; $r = 0.2$ m

Let, m = Balancing mass

θ = Position of balancing mass

$$\therefore m_1 r_1 = 200 \times 0.2 = 40 \text{ kg.m}$$

$$m_2 r_2 = 300 \times 0.15 = 45 \text{ kg.m}$$

$$m_3 r_3 = 240 \times 0.25 = 60 \text{ kg.m}$$

$$m_4 r_4 = 260 \times 0.3 = 78 \text{ kg.m}$$

$$\begin{aligned} \text{Now, } \Sigma H &= m_1 r_1 \cos \theta_1 + m_2 r_2 \cos \theta_2 + m_3 r_3 \cos \theta_3 + m_4 r_4 \cos \theta_4 \\ &= 40 \cos 0 + 45 \cos 45 + 60 \cos 120 + 78 \cos 255 \\ &= 21.63 \text{ kg.m} \end{aligned}$$

$$\begin{aligned} \Sigma V &= m_1 r_1 \sin \theta_1 + m_2 r_2 \sin \theta_2 + m_3 r_3 \sin \theta_3 + m_4 r_4 \sin \theta_4 \\ &= 40 \sin 0 + 45 \sin 45 + 60 \sin 120 + 78 \sin 255 \\ &= 8.44 \text{ kg.m} \end{aligned}$$

$$\text{Resultant, } R = \sqrt{[(\Sigma H)^2 + (\Sigma V)^2]} = \sqrt{(21.63^2 + 8.44^2)} = 23.22 \text{ kg.m}$$

We know that,

$$mr = R$$

$$\therefore m = \frac{R}{r} = \frac{23.22}{0.2} = 116.1 \text{ kg (Answer)}$$

$$\begin{aligned} \text{And } \tan \theta' &= \frac{\Sigma V}{\Sigma H} = \frac{8.44}{21.63} \\ \therefore \theta' &= 21.32^\circ \end{aligned}$$

Since θ' is the angle of the resultant R from the horizontal mass of 200 kg, therefore the angle of the balancing mass from the horizontal mass of 200 kg,

$$\theta = 180^\circ + 21.32^\circ = 201.32^\circ \text{ (Answer)}$$

10. (a) Define free vibrations, forced vibrations and damped vibrations. Give suitable examples. 6

1. Free or natural vibrations: When no external force acts on the body, after giving it an initial displacement, then the body is said to be under free or natural vibrations. The frequency of the free vibrations is called free or natural frequency. Examples of this type of vibration are pulling a child back on a swing and letting it go, or hitting a tuning fork and letting it ring.

2. Forced vibrations: When the body vibrates under the influence of external force, then the body is said to be under forced vibrations. The external force applied to the body is a periodic disturbing force created by unbalance. The vibrations have the same frequency as the applied force.

Note: When the frequency of the external force is same as that of the natural vibrations, resonance takes place. Example: When a washing machine shakes due to an imbalance.

3. Damped vibrations: When there is a reduction in amplitude over every cycle of vibration, the motion is said to be damped vibration. This is due to the fact that a certain amount of energy possessed by the vibrating system is always dissipated in overcoming frictional resistances to the motion. Some examples of damped vibrations are oscillations of branch of a tree, sound produced by tuning fork over longer distances, etc.

(b) Deduce an expression for the natural frequency of free transverse vibrations for a simply supported shaft carrying uniformly distributed mass m kg per unit length. 7

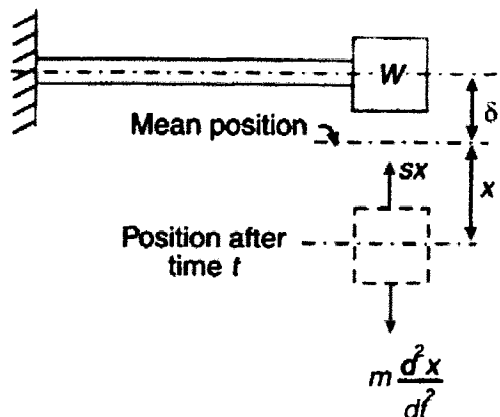
Consider a shaft of negligible mass, whose one end is fixed and the other end carries a body of weight W .

Let s = Stiffness of shaft,

δ = Static deflection due to weight of the body,

x = Displacement of body from mean position after time t .

m = Mass of body = W/g



Restoring force = $-s.x$ (i)

Accelerating force = $m \times \frac{d^2x}{dt^2}$ (ii) Figure: Natural frequency of free transverse vibration

Equating equations (i) and (ii), the equation of motion becomes

$$m \times \frac{d^2x}{dt^2} = -s.x \quad \text{or} \quad m \times \frac{d^2x}{dt^2} + s.x = 0$$

$$\therefore \frac{d^2x}{dt^2} + \frac{s}{m}.x = 0$$

Hence, the time period and the natural frequency of transverse vibrations are same as longitudinal vibrations are same as that of longitudinal vibrations, therefore -

$$\text{Time period, } t_p = 2\pi \sqrt{\frac{m}{s}}$$

$$\text{Natural frequency, } f_n = \frac{1}{t_p} = \frac{1}{2\pi} \sqrt{\frac{s}{m}} = \frac{1}{2\pi} \sqrt{\frac{g}{\delta}}$$

(c) A shaft of length 0.75 m, supported freely at the ends is carrying a body of mass 90 kg at 0.25 m from one end. Find the natural frequency of transverse vibration. Assume $E=200\text{GN/m}^2$ and shaft diameter = 5cm. 7

Solution:

Given: $l = 0.75 \text{ m}$; $m = 90 \text{ kg}$;

$a = AC = 0.25 \text{ m}$;

$E = 200 \text{ GN/m}^2 = 200 \times 10^9 \text{ N/m}^2$;

$d = 50 \text{ mm} = 0.05 \text{ m}$

We know that moment of inertia of the shaft,

$$I = \frac{\pi}{64} \times d^4 = \frac{\pi}{64} \times 0.05^4 \text{ m}^4 = 0.307 \times 10^{-6} \text{ m}^4$$

and static deflection at the load point (i.e. at point C),

$$\delta = \frac{W a^2 b^2}{3 E I l} = \frac{90 \times 9.81 \times (0.25)^2 \times (0.5)^2}{3 \times 200 \times 10^9 \times 0.307 \times 10^{-6} \times 0.75} = 0.1 \times 10^{-3} \text{ m } (\because b = BC = 0.5 \text{ m})$$

We know that natural frequency of transverse vibration,

$$f_n = \frac{0.4985}{\sqrt{\delta}} = \frac{0.4985}{\sqrt{0.1 \times 10^{-3}}} = 49.85 \text{ Hz (Answer)}$$

11.(a) Classify internal combustion engines.

5

Book: Fundamentals of Mechanical Engineering vol.-1, chapter-2

(b) “Factors tending to increase denotation of SI engines tend to reduce knock in CI engines”—Discuss the validity of the statement.

7

Characteristics tending to reduce knock:

Characteristics	SI Engine	CI Engine
Fuel ignition temperature	High	Low
Ignition delay	Long	Short
Compression ratio	Low	High
Inlet temperature	Low	High
Inlet pressure	Low	High
Combustion wall temperature	Low	High
Engine speed	High	Low
Engine size	Small	Large

So “Factors tending to increase detonation on SI engines tend to reduce knock in CI engines” the statement is valid.

(c) A 4-stroke diesel engine has a cylinder bore of 150mm and a stroke of 250mm. The crankshaft speed is 300 rpm and the fuel consumption is 1.2 kg/hr having a calorific value of 39900 kJ/kg. The indicated mean effective pressure is 5.5 bar, if the compression ratio is 15 and cut off is 1.8. Calculate the indicated thermal efficiency and the air standard efficiency.

Solution:

Given, $P_m = 5.5 \text{ bar}$; $L = 0.25 \text{ m}$; $D = 0.15 \text{ m}$; $A = \frac{\pi}{4} D^2 = \frac{\pi}{4} \cdot 15^2 = 0.0177 \text{ m}^2$

$N = 300 \text{ rpm}$; $n = \frac{N}{2} = 150$; Compression ratio, $r = 15$; Cut off ratio, $\rho = 1.8$

$\gamma = 1.4$; $m_f = 1.2 \text{ kg/hr}$; $C = 39900 \text{ kJ/kg}$

Now, Indicated Power = $\frac{100 k P_m L A n}{60}$

$$= \frac{100 \times 5.5 \times 0.25 \times 0.0177 \times 150}{60} = 6.08 \text{ kW}$$

$$\text{Indicated thermal efficiency} = \frac{\text{I.P.} \times 3600}{m_f \times C} = \frac{6.08 \times 3600}{1.2 \times 39900} = 45.71\% \text{ (Answer)}$$

$$\begin{aligned} \text{Air Standard efficiency} &= 1 - \frac{1}{r^{\gamma-1}} \left[\frac{\rho^\gamma - 1}{\gamma(\rho - 1)} \right] \\ &= 1 - \frac{1}{15^{1.4-1}} \left[\frac{1.8^{1.4} - 1}{1.4(1.8 - 1)} \right] = 61.4\% \text{ (Answer)} \end{aligned}$$

12.(a) What is meant by thermal boundary layer?

5

Answer:

A thermal boundary layer develops when a fluid at a specified temperature flows over a surface that is at a different temperature, as shown in the figure.

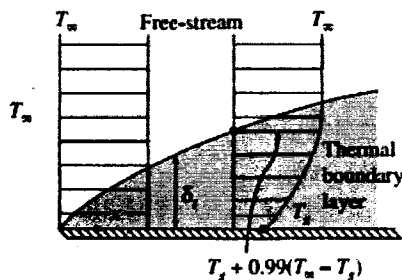


Figure: Thermal boundary layer on a flat plate

Consider the flow of a fluid at a uniform temperature of T_∞ over an isothermal flat plate at temperature T_s . The fluid particles in the layer adjacent to the surface will reach thermal equilibrium with the plate and assume the surface temperature T_s . These fluid particles will then exchange energy with the particles in the adjoining-fluid layer, and so on. As a result, a temperature profile will develop in the flow field that ranges from T_s at the surface to T_∞ sufficiently far from the surface. The flow region over the surface in which the temperature variation in the direction normal to the surface is significant is the thermal boundary layer. The thickness of the thermal boundary layer t at any location along the surface is defined as the distance from the surface at which the temperature difference $T - T_s$ equals $0.99(T_\infty - T_s)$. Note that for the special case of $T_s = 0$, we have $T = 0.99T_\infty$ at the outer edge of the thermal boundary layer, which is analogous to $u = 0.99u_\infty$ for the velocity boundary layer.

The thickness of the thermal boundary layer increases in the flow direction, since the effects of heat transfer are felt at greater distances from the surface further downstream.

(b) A large vertical plate 4m high is maintained at 60°C and exposed to 10 atmospheric air at 10°C . Calculate the heat transfer if the plate is 10m wide.

Solution:

We first determine the film temperature as

$$T_f = \frac{(T_s + T_\infty)}{2} = 35^\circ \text{C} = 308\text{K}$$

The properties are: $\beta = \frac{1}{308} = 3.25 \times 10^{-3}$, $K = 0.02685 \text{ W/mK}$, $V = 16.5 \times 10^{-6}$, $Pr = 0.7$

The Rayleigh number can be found:

$$Ra = GrPr = \frac{9.8 \times 3.25 \times 10^{-3} \times (60 - 10) \times 4^3}{(16.5 \times 10^{-6})^2} \times 0.7 = 3.743 \times 10^{11}$$

The Nusselt number can be found:

$$Nu = 0.1Ra^{1/3} = 0.1 \times 3.743 \times 10^{11} = 720.7$$

The heat-transfer coefficient is $h = \frac{Nu K}{L} = \frac{720.7 \times 0.02685}{4} = 4.84 \text{ W/m}^2\text{K}$

The heat transfer is: $Q = hA(T_s - T_\infty)$

$$= 4.84 \times 4 \times 10 \times (60 - 10) = 9.675 \text{ KW (Answer)}$$

(c) Define comfort. What are the factors affecting the thermal comfort? 5

Thermal Comfort: Human thermal comfort is defined as a condition of mind, which expresses satisfaction with the surrounding environment. High temperatures and humidity provide discomfort sensations and sometimes heat stress (i.e., reducing the body's ability to cool itself).

Factors affecting the thermal comfort:

- (i) Temperature of air
- (ii) Humidity of air
- (iii) Purity of air
- (iv) Motion of air
- (v) Clothing
- (vi) Sex and age
- (vii) Activity

13. (a) Distinguish among welding, brazing and soldering. 5

Welding	Brazing	Soldering
Base metal fused	Base metal doesn't fuse	Base metal doesn't fuse
High temperature, high power	Low temperature, low power.	Low temperature, low power.
High distortion.	Low distortion	No distortion
High stress in joints	Low stress in joint	Low stress in joint
Microstructure of base metal change	No change in microstructure in base metal	No change in microstructure in base metal
Dissimilar metal difficult to join	Dissimilar metal easy to join	Dissimilar metal easy to join
Thin sheet difficult to weld.	Thin sheet can be joined	Thin sheet can be joined
High strength of joint	Low strength of joint	Low strength of joint

(b) What are the functions of coating on shielded electrodes? 5

Answer: Coating on shielded electrodes provides a protective gaseous atmosphere to prevent oxygen, hydrogen, and nitrogen picked up by the molten metal. Reduce spatter of weld metal – when coating burns off slower than the core. Slows down the cooling rate of

the weld (due to the protective layer of slag) to prevent hardening.

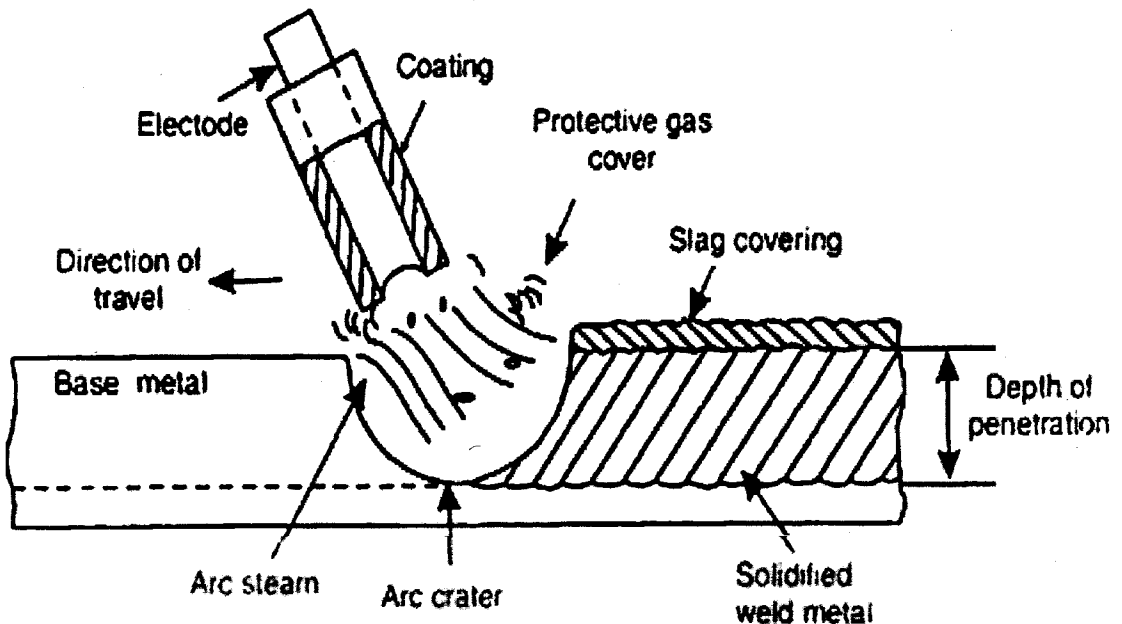


Fig: Arc welding with a coated electrode

(c) Explain the principles of operation of resistance welding with neat sketches. 10

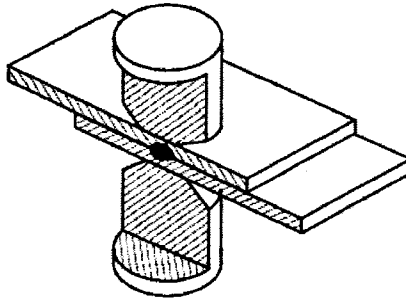
Resistance Welding:

Resistance welding is a welding technology widely used in manufacturing industry for joining metal sheets and components. The weld is made by conducting a strong current through the metal combination to heat up and finally melt the metals at localized point(s) predetermined by the design of the electrodes and/or the work-pieces to be welded. A force is always applied before, during and after the application of current to confine the contact area at the weld interfaces and, in some applications, to forge the work-pieces.

Resistance welding processes/ principles of operation:

Depending on the shape of the work-pieces and the form of the electrodes, resistance welding processes can be classified into several variants among which the most commonly used are spot welding, projection welding, seam welding and butt welding. More details are described below:

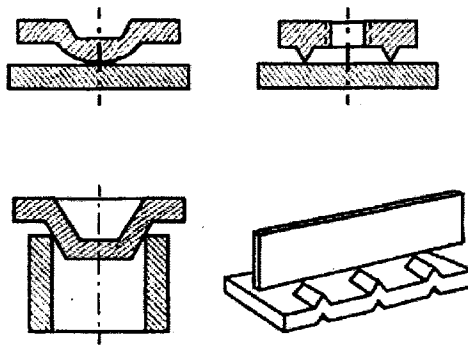
- **Resistance Spot Welding**



Spot welding is a resistance welding process for joining metal sheets by directly applying opposing forces with electrodes with pointed tips. The current and the heat generation are localized by the form of the electrodes. The weld nugget size is usually defined by the electrode tip contact area.

Spot welding is the predominant joining process in automotive industry for assembling the automobile bodies and large components. It is also widely used for manufacturing of furniture and domestic equipment etc.

- **Resistance Projection Welding**

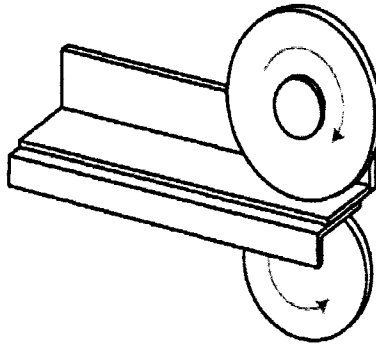


Projection welding is a resistance welding process for joining metal components or sheets with embossments by directly applying opposing forces with electrodes specially designed to fit the shapes of the work-pieces. The current and the heat generation are localized by the shape of the work-pieces either with their natural shape or with specially designed projection. Large deformation or collapse will occur in the projection part of the work-pieces implying high process/machine dynamics.

Projection welding is widely used in electrical electronics, automotive and construction

industries, and manufacturing of sensors, valves and pumps etc.

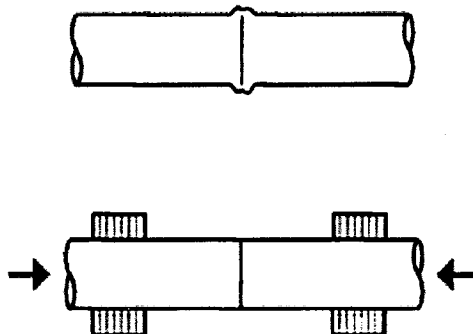
- **Resistance Seam Welding**



Seam welding is a resistance welding process for joining metal sheets in continuous, often leak tight, seam joints by directly applying opposing forces with electrodes consisting of rotary wheels. The current and the heat generation are localized by the peripheral shapes of the electrode wheels.

Seam welding is mostly applied in manufacturing of containers, radiators and heat exchangers etc.

- **Resistance Butt Welding**



Butt welding is a resistance welding process for joining thick metal plates or bars at the ends by directly applying opposing forces with electrodes clamping the work-pieces. A forging operation is applied after the work-pieces are heated up. Often no melt occurs, thus a solid-state weld can be obtained.

Butt welding is applied in manufacturing of wheel rims, wire joints and railway track joints etc.

- **Single-Sided (One-Sided) Resistance Welding**

Is a special resistance welding process where a spot weld is made with only one electrode accessing from one side to the weld zone with or without a backing plate from the other side. Low weld force is usually used, which limits the single-sided (one-sided) spot welding to joining of relatively thin sheets. It may be useful for welding components with limitation of electrode access from both sides.

- **Resistance Weld Bonding**

Is a combined joining process with adhesive bonding and resistance welding. The adhesive is applied to the faying surfaces of sheets to be welded, and subsequently resistance spot weld is made through the sheets before curing of the adhesive. The joint can have good strength from the spot welding and good stiffness from the adhesive bonding.

- **Cross Wire Welding**

Is a resistance welding process for joining bars or wires in cross joints by directly applying opposing forces with usually flat electrodes. The current and the heat generation are localized at the contact points of the crossed bars or wires. Cross wire welding is widely used in construction and electrical industry as well as for manufacturing of metal wire nets and shopping trolleys etc.

- **Indirect Spot Welding**

Is a special resistance welding process where a single spot weld is made with one electrode directly connecting to the weld zone, while the other electrode is offset at a distance, but still conducts the current along the work-piece.

- **Series Spot Welding**

Is a special resistance welding process where two spot welds are made at the same time with two electrodes offset at a distance but still conducting the current along the work-pieces between the two welds.

- **Micro Resistance Welding**

Refers to the resistance welding processes for joining micro or miniaturized components, which in principle can be any of the above-mentioned process variants but in a micro scale.

14. (a) Draw a typical schematic diagram to show the key components of thermal power plant. 5

Answer:

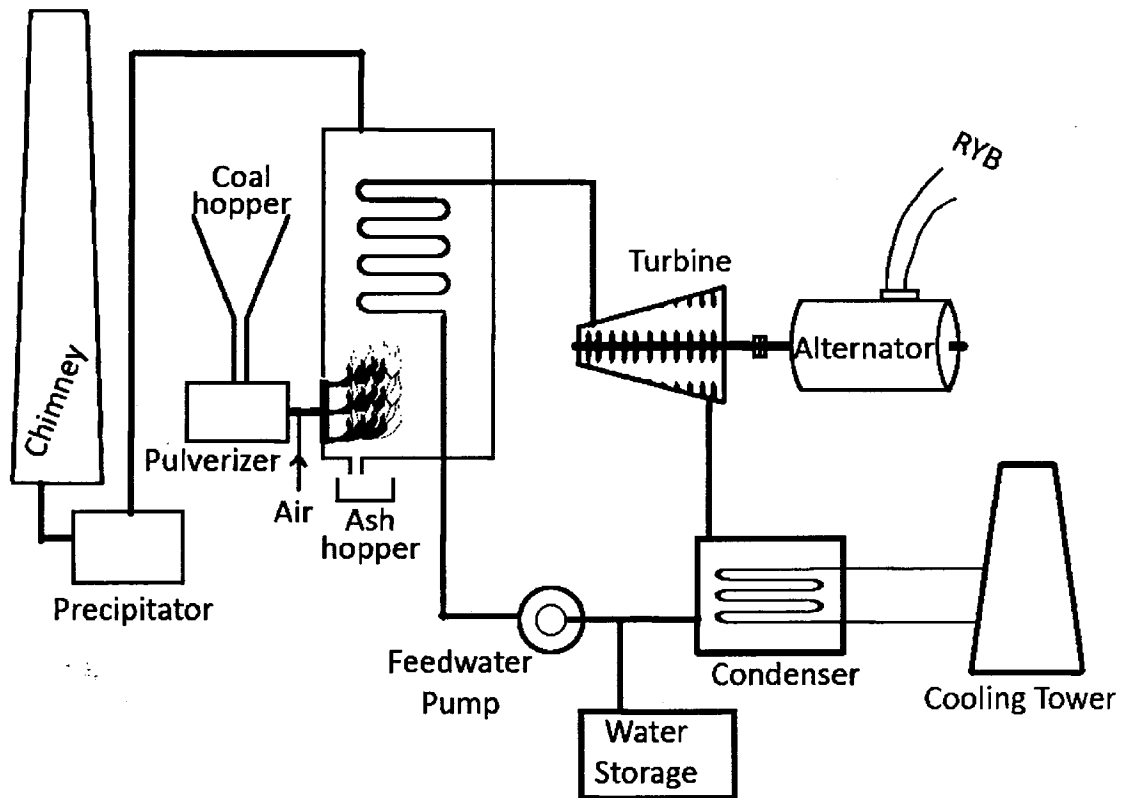


Fig.: Schematic diagram of a thermal power plant

(b) Distinguish between window type and split type air-conditions.

5

Answer:

Window Air Conditioner	Split Air Conditioner
Heat exchangers, compressors, motors and connecting pipes are placed on the same base	It consists of 2 units – Indoor Unit & Outdoor unit
Occupies more space than split AC	Occupies less space
Installation is easy	Installation is not as easy as Window AC
Multiple cooling units is not possible	Multiple cooling unit is possible
Cheaper than the split AC for the same tonnage	Costlier than Window AC for the same tonnage
More noise (AIR) than Split AC	Less noise compared to Window AC
Easy serviceability	Difficult for service
Max. capacity is 2.0Ton	Capacity not restricted to 2.0Ton

(c) What are the key components of the cooling load of a typical office room?

10

Answer:

Components of cooling load calculation are:

(5) Internal heat load:

(c) Heat load from lighting system and equipment's

\dot{Q}_e = sum of ratings of equipments and lighting lamps

(d) Heat gain from human body:

\dot{Q}_b = No. of occupants \times heat gain rate per person

(6) Wall heat load: Heat loss or gain by thermal transmission through a building wall can be calculated as

$$\dot{Q}_w = UA(\Delta T)_{wall}$$

(7) Infiltration and ventilation load: Infiltration is defined as the uncontrolled entry of outside air directly into the conditioned space due to wind and bouncy effect arising out of temperature difference between inside and outside environments.

Ventilation is defined as the air intentionally mixed with recirculated air to meet the oxygen requirement of the occupants.

(8) Solar heat gain through glass windows and walls: The solar load can be given by the directly transmitted radiation as $Q_s(t) = A_w S(t) E$

Where, $S(t)$ is the solar heat gain coefficient function, t is the time, E is the irradiance of the direct solar beam W/m^2 , and A_w is the window area of the data center in m^2 .

36th BCSSUNDORBAN

Subject code: 901

Time allowed: 4 hours

Full marks- 200

- [N.B (i) Answer any 10 questions
(ii) Figures in the right margin indicates full marks
(iii) Symbols have their usual meanings
(iv) Assume any reasonable value for missing data, if required.]**

Marks

10×2

= 20

- 1. Choose the correct statements**
- (a) The variable which control the physical properties of a perfect gas are-**
- (i) Pressure exerted by the gas
 - (ii) Volume occupied by the gas
 - (iii) Temperature of the gas
 - (iv) All of the above**
- (b) Which of the following statement is correct?**
- (i) A grey body is one which absorbs all the radiations incident on it
 - (ii) At the thermal equilibrium the absorptivity and emissivity are same**
 - (iii) The energy absorbed by a body to the total energy falling on it is called Emissivity.
 - (iv) A perfect body is one which is black in color
- (c) A good refrigerator should have-**
- (i) High latent heat of vaporization & low freezing point**
 - (ii) High operating pressure & low freezing point
 - (iii) High specific volume & high latent heat of vaporization
 - (iv) Low COP & low freezing point
- (d) A differential manometer is used to measure-**
- (i) Atmospheric pressure
 - (ii) Pressure in pipes & channels
 - (iii) Pressure in venturi meter
 - (iv) Difference of pressure between two points in a pipe**
- (e) The function of a guide vane in a reaction turbine is to-**
- (i) allow the water to enter the runner without shock
 - (ii) allow the water to flow over them, without forming eddies
 - (iii) allow the required quantity of water to enter the turbine
 - (iv) all of the above**
- (f) A centrifugal pump will start to delivering liquid only when the Pressure rise in the impeller is equal to-**
- (i) kinetic head
 - (ii) velocity head
 - (iii) manometric head**

- (iv) static head
- (g) When a cantilever beam is located with a concentrated loads, the Bending moment diagram will be a-
- (i) horizontal straight line
 - (ii) vertical straight line
 - (iii) inclined straight line
 - (iv) parabolic curves
- (h) The maximum shear stress in a thin cylindrical shell subjected to Internal pressure P is-
- (i) pd/t (ii) $pd/2t$ (iii) $pd/4t$ (iv) $pd/8t$
- (i) Euler's formula holds good for only-
- (i) Short columns
 - (ii) Long columns
 - (iii) Both long & short columns
 - (iv) Weak columns
- (j) The object in producing draught in a boiler is-
- (i) to provide an adequate supply of air for the fuel combustion
 - (ii) to exhaust the gasses of combustion from the combustion chamber
 - (iii) to discharge these gasses to the atmosphere through the chimney
 - (iv) all of the above
2. (a) State the 1st law of thermodynamics. Prove the 1st law of thermodynamics is the law of Conversion of energy.

07

1st law of thermodynamics:

- a) The heat and mechanical work are mutually convertible. i.e. $\oint dQ = \oint dW$
- b) The energy can neither be created nor destroyed though it can be transformed from one to another form. i.e. $\delta Q - \delta W = \delta E$

Energy conservation:

Let us consider a process that involves only heat transfer but no work interaction. A hot potato taken from an oven is exposed to the atmosphere in room temperature. As a result, its energy will decrease. In absence of other effects, the decrease of total energy of the potato becomes equal to the amount of heat transfer to the surroundings. Therefore, the principle of conservation of energy can be expressed as,

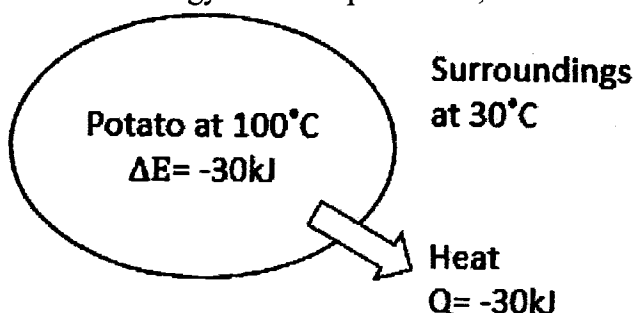


Fig. Hot Potato Losing its energy as heat to the surroundings

$$-\Delta E = -Q; \text{ where } \Delta E = E_2 - E_1$$

$$\Rightarrow Q = \Delta E; \text{ where } W = 0$$

In the absence of any work interaction between a system and its surroundings, the amount of heat transfer is equal to the change in the energy of a system. [Proved]

(b) What is the viscosity? Derive and discuss the Newton's law of viscosity. 07

Viscosity: See at Fundamentals of mechanical engineering vol.1, Chapter-3.

(c) An engineer claim his engine to develop 3.75 kW. On testing, the engine 06
0.44 kg of fuel per hour having a calorific value 42000 kJ/kg. The maximum temperature recorded in the cycle is 1400°C & minimum is 350°C. Check whether the engineer Claim is correct or not.

Solution:

Given,

$$P' = 3.75 \text{ kW}; T_1 = 350^\circ\text{C} = 623\text{K}; T_2 = 1400^\circ\text{C} = 1673\text{K};$$

$$m = 0.44 \text{ kg/hour}; C_v = 42000 \text{ kJ/kg}$$

$$\text{We know, } \eta = \frac{\text{Output}}{\text{input}} = 1 - \frac{T_1}{T_2} = 1 - \frac{623}{1673} = 0.6276$$

$$\Rightarrow \text{Output, } P = 0.6276 \times \text{input}$$

$$= 0.6276 \times \text{input} = 0.6276 \times \frac{0.44 \times 42000 \times 10^3}{3600}$$

$$\therefore \text{Output, } P = 3.22 \text{ kJ/s} = 3.22 \text{ kW s}$$

So, the claim is not correct. (Answer)

3. (a) Differentiate between boiler mountings and accessories. Mention 3 boiler mountings & accessories that are generally used. Also mention their functions. 6

Answer:

Boiler Mountings	Boiler Accessories
It amplifies the safety of a boiler	It amplifies the efficiency of a boiler
Mountings are necessary for changeable the boiler.	Accessories are not necessary but their use is enviable.
Commonly they are mounted on boiler shell.	They are not located in the boiler shell.
Mountings are installed from simple working and control of a boiler.	Accessories are installed to amplify the efficiency of a boiler.
It amplifies the safety of a boiler	It amplifies the efficiency of a boiler
Mountings are necessary for changeable the boiler.	Accessories are not necessary but their use is enviable.

Rest part: see at "Fundamentals of Mechanical engineering vol.1, chapter-1"

(b) What are differences between an Air Handling Unit (AHU) & a Fan Coil Unit (FCU) used in an air conditioning system? 6

Answer:

Air Handling Unit (AHU)	Fan Coil Unit (FCU)
AHU is a bigger system.	FCU smaller system than AHU.

AHU is more complex.	FCU is simple in design.
Duct is used.	No duct used in the system.
AHU treats outside air.	FCU recirculate the air.
AUH has section for reheating and humidifying.	FCU does not have reheating and humidifying.
AUH has less noise.	FCU has more noise.

(c) With the help of net distinguish between a split type air conditioner & a window type air conditioner. 8

Answer:

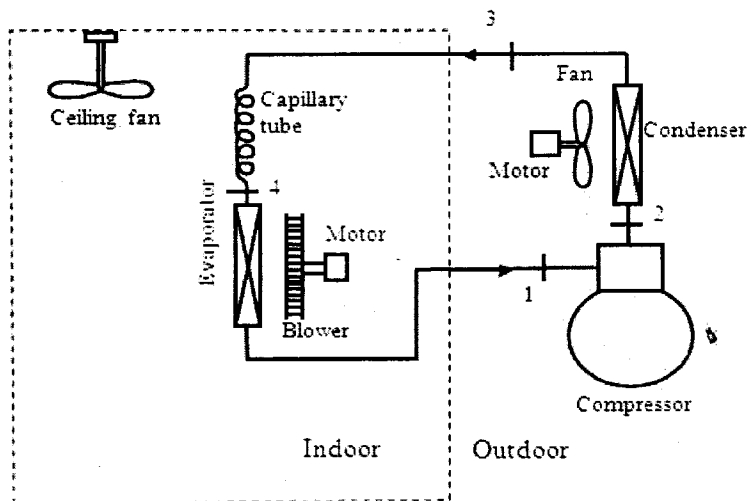


Fig: Split type AC

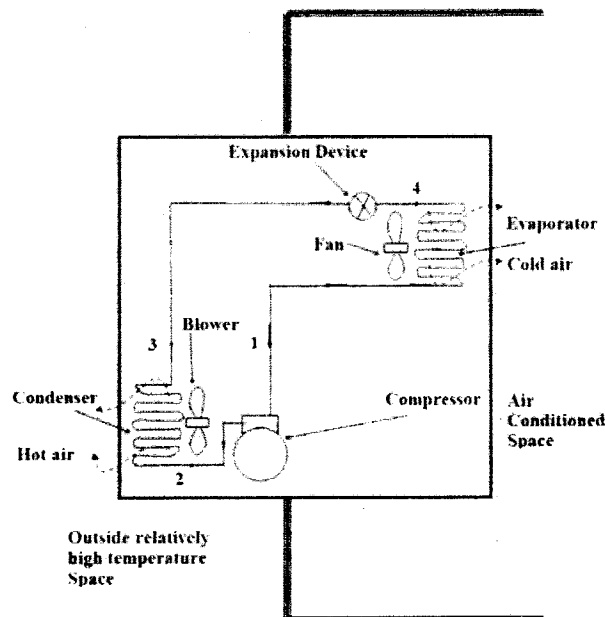


Fig: Window type AC

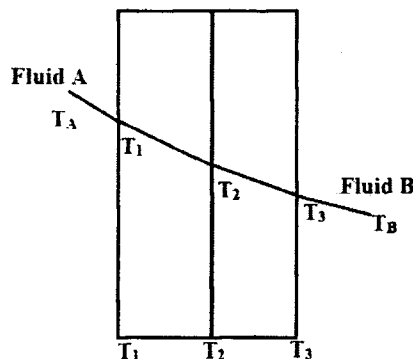
Window Air Conditioner	Split Air Conditioner
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Max. capacity is 2.0Ton	Capacity not restricted to 2.0Ton

4. (a) What is meant by the term 'one-dimensional' when applied to conduction problems? Derive an overall heat transfer equation for a composite wall consisting of two layer's. 7

Meaning of 'one dimensional' when applied to conduction:

The term "one dimensional" refers to the fact that only one coordinate is needed to describe the spatial variation of the dependent variables. Hence, in a one-dimensional system, temperature gradients exist along a single coordinate direction, and heat transfer occurs exclusively in that direction.

Derivation of overall heat transfer equation:



Let,

Fluid at the left of composite wall A

Fluid at the right of composite wall B

Temperature at the left side wall T_1

Temperature where the two layer met T_2

Temperature at the right side wall T_3

1. Convection between fluid A and wall surface 1

$$q = h_1 A (T_A - T_1)$$

$$= \frac{T_A - T_1}{\frac{1}{h_1 A}}$$

$$R_A = \frac{1}{h_1 A}$$

2. Conduction between wall surface 1 and 2

$$q = K_1 A \frac{T_1 - T_2}{\Delta x_1}$$

$$= \frac{T_1 - T_2}{\frac{\Delta x_1}{K_1 A}}$$

$$R_{\text{wall1}} = \frac{\Delta x_1}{K_1 A}$$

3. Conduction between wall surface 2 and 3

$$q = K_2 A \frac{T_2 - T_3}{\Delta x_2}$$

$$= \frac{T_2 - T_3}{\frac{\Delta x_2}{K_2 A}}$$

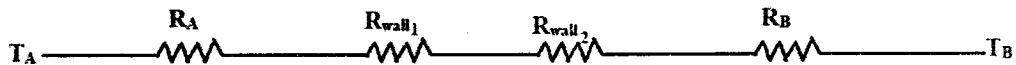
$$R_{\text{wall2}} = \frac{\Delta x_2}{K_2 A}$$

4. Convection between wall surface 3 and fluid B

$$q = h_2 A (T_3 - T_B)$$

$$= \frac{T_3 - T_B}{\frac{1}{h_2 A}}$$

$$R_B = \frac{1}{h_2 A}$$



$$\text{Overall } q = \frac{T_A - T_B}{R_{\text{overall}}}$$

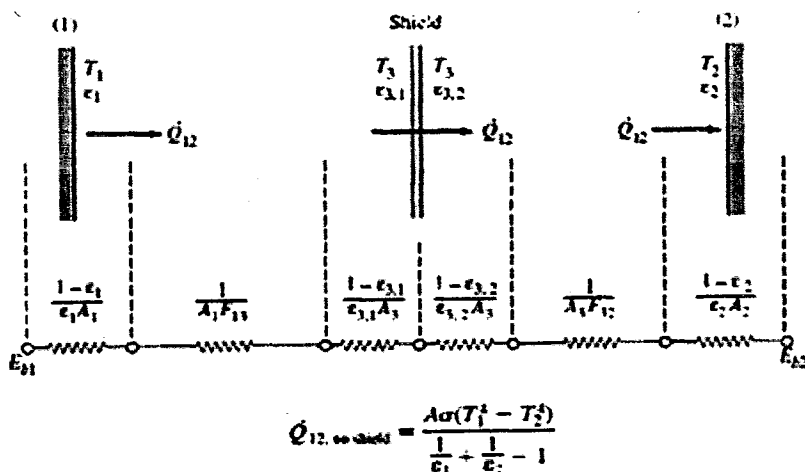
$$= \frac{T_A - T_B}{\frac{1}{h_1 A} + \frac{\Delta x_1}{K_1 A} + \frac{\Delta x_2}{K_2 A} + \frac{1}{h_2 A}}$$

$$\text{Overall } q = \frac{A(T_A - T_B)}{\frac{1}{h_1} + \frac{\Delta x_1}{K_1} + \frac{\Delta x_2}{K_2} + \frac{1}{h_2}}$$

(b) Describe the Brayton cycle for a gas turbine with inter cooling, reheating Refrigeration and draw schematic diagram. 8

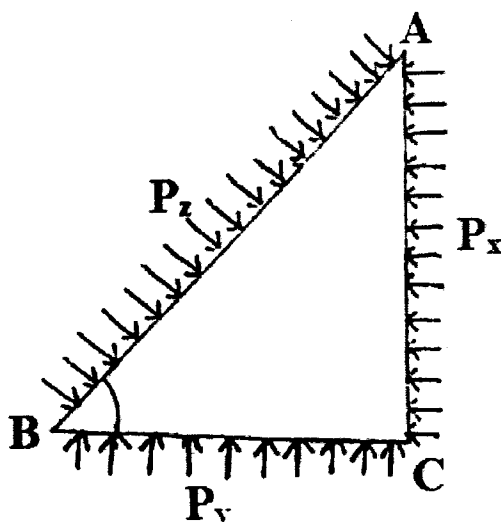
Answer: see at Fundamental of Mechanical Engineering vol. 1, chapter-5.

(c) Draw the radiation circuit diagram for a radiation shield placed between two plates. 5



5. (a) What is meant by pressure at a point? Prove that pressure is same in all Direction at a point in a static liquid. 7

Pressure at a point means force acting on that point at per unit area.



Let,

P_x = Intensity of horizontal pressure on the element of the liquid

P_y = Intensity of vertical pressure on the element of the liquid

P_z = Intensity of pressure on the diagonal of the triangular element of the liquid

θ = Angle of the triangular element of liquid

Now pressure on vertical side AC of the liquid

$$P_x = p_x \times AC$$

Similarly,

$$P_y = p_y \times BC$$

$$P_z = p_z \times AB$$

Since the element of the liquid is at rest, therefore sum of horizontal and vertical

components of the liquid pressures must be equal zero.

Resolving the forces horizontally,

$$P_z \sin \theta = P_x$$

$$\Rightarrow p_z \cdot AB \cdot \sin \theta = p_x \cdot AC$$

$$\Rightarrow p_z \cdot AC = p_x \cdot AC \quad [AC = AB \sin \theta]$$

$$\Rightarrow p_z = p_x$$

Now resolving the forces vertically,

$$P_z \cos \theta = P_y - W$$

$$\Rightarrow P_z \cos \theta = P_y \quad [\text{since we consider a small triangular element}]$$

$$\Rightarrow p_z \cdot AB \cdot \cos \theta = p_y \cdot BC$$

$$\Rightarrow p_z \cdot BC = p_y \cdot BC \quad [AB \cos \theta = BC]$$

$$\Rightarrow p_z = p_y$$

From the above equations it can be said that

$$p_x = p_y = p_z$$

Thus the intensity of pressure at any point in a fluid at rest is same in all directions

[Proved]

(b) What are the relative advantages using a venturi meter to measure flow compared with using an orifice meter? 5

Advantages of venturi meter:

- Less chance of getting stuck with sediment.
- The discharge coefficient is high.
- Its behaviour can be predicted perfectly.
- It can be installed vertically, horizontally, inclined.
- They are more precise and can be used for a wide range of flows.
- About 90% of the pressure drop can be recovered.

Disadvantages of orifice meter:

- Requires homogeneous fluid.
- Requires single phase liquid
- It requires the flow of axial velocity vectors.
- It causes a pressure drop in the fluid.

Its accuracy is affected by the density, pressure and viscosity of the fluid.

(c) A centrifugal pump delivers 30 liters of water per sec to height of 18m through a pipe of 90m long and of 100mm diameter. If the overall efficiency of the pump is 75% find power required to drive the pump. Take $f=0.012$ 8

Solution: Given, $Q=30$ liter/sec $= 30 \times 10^{-3} \text{ m}^3/\text{s}$; $H=18\text{m}$; $l=90\text{m}$; $D=100\text{mm}$; $\eta = 0.75$; $f = 0.012$.

$$\text{Now, } Q = A \times V \Rightarrow V = \frac{Q}{A} = \frac{30 \times 10^{-3}}{\frac{\pi}{4} \times 100^2} = 3.82 \times 10^{-6}$$

$$h_f = \frac{4flv^2}{2gD} = \frac{4 \times 0.012 \times 90 \times (3.82 \times 10^{-6})^2}{2 \times 9.81 \times 100} = 3.21 \times 10^{-14}$$

$$P_{\text{out}} = \gamma Q(H + h_f)$$

$$= 1000 \times 9.81 \times 30 \times 10^{-3} (18 + 3.21 \times 10^{-14})$$

$$= 5.29 \text{ KW}$$

Power required to drive the pump

$$= \frac{5.29}{0.75} = 7.05 \text{ KW (Answer)}$$

6.(a) What do you mean by “principle stresses”? “Principle stresses occurs on the planes of zero shearing stresses” prove it. 6

Principal stress: The normal stresses, acting on a principal plane are known as principal stresses.

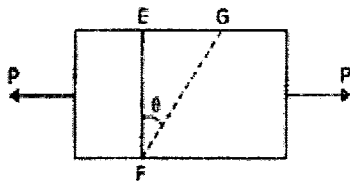


Figure: 1

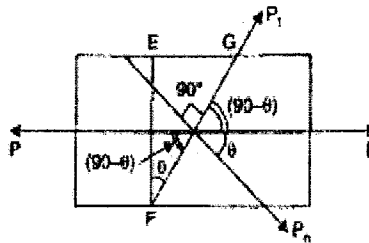


Figure: 2

Figure 1 shows a rectangular member of uniform cross-sectional area A and of unit thickness.

Let, P = Axial force acting on the member

A = Cross-sectional area, which is perpendicular to the line of axis of the force P .

The stress along x-axis, $\sigma = \frac{P}{A}$

Hence, the member is subjected to a stress along x-axis

Consider a cross-section EF which perpendicular to the line of action of the force P .

Then, area of section $EF = EF \times 1 = A$

The stress on the section EF is given by

$$\sigma = \frac{P}{A}$$

The stress on the section EF is entirely normal stress. There is no shear (tangential) stress on the section EF . So the section EF is principal plane.

Now consider a section FG at an angle θ with the normal cross-section EF as shown in figure 2.

Area of section $FG = FG \times 1$ (member is having unit thickness)

$$= \frac{EF}{\cos \theta} \times 1$$

$$= \frac{A}{\cos \theta}$$

\therefore Stress on the section, FG

$$= \frac{P}{\frac{A}{\cos \theta}}$$

$$= \sigma \cos \theta$$

This stress may be resolved in two components, one is normal components and another is tangential (shear) components.

The normal stress and shear stress on the section FG are obtained as given below;

Let, P_n = force normal to section FG = $p \cos \theta$

P_t = Tangential force = $p \sin \theta$

σ_n = Normal stress

σ_t = Shear (tangential) stress

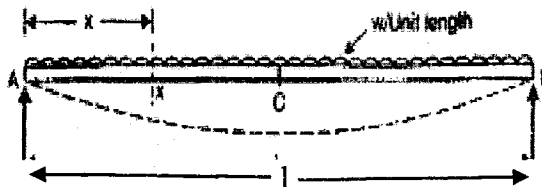
$$\text{Normal stress } \sigma_n = \frac{\frac{p \cos \theta}{A}}{\cos \theta} = \sigma (\cos \theta)^2$$

$$\text{Tangential or shear stress } \sigma_t = \frac{\frac{p \sin \theta}{A}}{\cos \theta} = \sigma \sin \theta \cos \theta = \frac{\sigma}{2} \sin 2\theta$$

Now, if $\theta = 0$ then FG plane coincide with EF plane and shear stress becomes Zero. So the plane becomes principal plane. So the plane has principal stress only.

So the principal stresses occurs on the plane of Zero shearing stresses. (Proved)

(b) Determine the maximum deflection in a simply supported beam of length l carrying a uniformly distributed load of wl unit weight applied over its entire length. 7



The above figure shows the simply supported beam of length l carrying UDL w per unit length. The reaction at A and B will be equal and maximum deflection will be at the centre.

$$\text{Reaction at A and B, } R_A = R_B = \frac{wl}{2}$$

Consider a section X at a distance x from A. The bending moment at this section is given by

$$M_x = R_A x - w \times x \times \frac{x}{2} = \frac{wl}{2} x - \frac{wx^2}{2}$$

But B.M at any section

$$M = EI \frac{d^2 y}{dx^2} \text{ now equating the two value}$$

$$EI \frac{d^2 y}{dx^2} = \frac{wl}{2} x - \frac{wx^2}{2}$$

Integrating the above Equation;

$$EI \frac{dy}{dx} = \frac{wl}{2} \times \frac{x^2}{2} - \frac{w}{2} \times \frac{x^3}{3} + C_1 \text{ where } C_1 \text{ is the constant of integration. ... (i)}$$

Integrating the above equation again

$$EI y = \frac{wl}{4} \times \frac{x^3}{3} - \frac{w}{6} \times \frac{x^4}{4} + C_1 x + C_2 \text{ ... (ii)}$$

Where C_2 is another constant of integration

Applying boundary conditions:

(i) at $x = 0, y = 0$

(ii) at $x = l, y = 0$

Substituting the first boundary conditions in equation (ii), we get

$$C_2 = 0$$

Substituting the second boundary conditions in equation (ii), we get

$$0 = \frac{wl}{4} \times \frac{l^3}{3} - \frac{w}{6} \times \frac{l^4}{4} + C_1 l$$

$$\therefore C_1 = -\frac{wl^3}{12} + \frac{wl^3}{24} = -\frac{wl^3}{24}$$

Substituting the value of C_1 in equation (i) and (ii)

$$EI \frac{dy}{dx} = \frac{wl}{2} \times \frac{x^2}{2} - \frac{w}{2} \times \frac{x^3}{3} - \frac{wl^3}{24} \quad (\text{iii})$$

And

$$Ely = \frac{wl}{4} \times \frac{x^3}{3} - \frac{w}{6} \times \frac{x^4}{4} + \left(-\frac{wl^3}{24}\right)x + 0$$

$$Ely = \frac{wlx^3}{12} - \frac{wx^4}{24} - \frac{wl^3x}{24} \dots \dots \dots (\text{iv})$$

The equation (iv) is known as deflection equation.

For maximum deflection, $x = \frac{l}{2}$ so the equation (iv) becomes

$$Ely_{\max} = \frac{wl}{12} \left(\frac{l}{2}\right)^3 - \frac{w}{24} \left(\frac{l}{2}\right)^4 - \frac{wl^3}{24} \left(\frac{l}{2}\right)$$

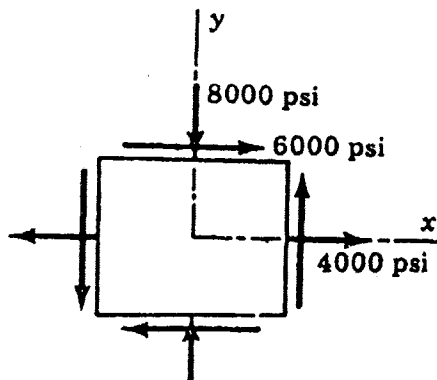
$$y_{\max} = -\frac{5wl^4}{EI384}$$

Negative sign indicates downward deflection

So the downward deflection is;

$$y_{\max} = \frac{1}{EI} \frac{5Wl^3}{384} \quad [wl = W = \text{total load}]$$

(c) If an element is subjected to the state of stress shown on figure, find the principal stresses. Also find the stress component on a plane at 30° counter clockwise from the X face. 7



Solution:

Principal stress:

$$\begin{aligned} \sigma_1 &= \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left[\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (\tau_{xy})^2\right]} \\ &= \frac{4000 + (-8000)}{2} + \sqrt{\left[\left(\frac{4000 - (-8000)}{2}\right)^2 + (6000)^2\right]} \end{aligned}$$

$$= 6485 \text{ psi (Answer)}$$

And

$$\begin{aligned}\sigma_2 &= \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left[\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + (\tau_{xy})^2\right]} \\ &= \frac{4000 + (-8000)}{2} - \sqrt{\left[\left(\frac{4000 - (-8000)}{2}\right)^2 + (6000)^2\right]} \\ &= -10485 \text{ psi (Answer)}\end{aligned}$$

Stress Component:

$$\begin{aligned}\sigma &= \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta - \tau_{xy} \sin 2\theta \\ \sigma &= \frac{4000 + (-8000)}{2} + \frac{4000 - (-8000)}{2} \cos 60^\circ - (-6000) \sin 60^\circ \\ &= 6196 \text{ psi (Answer)}\end{aligned}$$

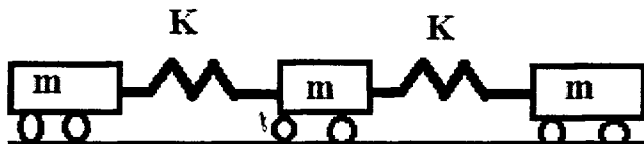
$$\tau = \frac{\sigma_x - \sigma_y}{2} \sin 2\theta + \tau_{xy} \cos 2\theta$$

$$\begin{aligned}\tau &= \frac{4000 - (-8000)}{2} \sin 60^\circ + (-6000) \cos 60^\circ \\ &= 2196 \text{ psi (Answer)}\end{aligned}$$

7. (a) Differentiate between static and dynamic balancing of a shaft and then show that, for static balancing center of mass of all the revolving masses must lie on the axis of the rotation of the shaft. 6

Static balancing	Dynamic balancing
A rotating mass is said to be statically balanced, if the rotating mass can rest without turning, at any angular position in its bearing. This condition is attained when the sum of the centrifugal forces on the rotating mass due to unbalanced masses is zero in any radial direction.	A rotating mass is said to be dynamically balanced, when it does not vibrate in its running state. To make a rotating mass dynamically balanced, it must first be statically balanced.
Only forces are balanced.	Both force and couple are balanced.

(b) For the unbalanced system shown in figure, find the frequency of vibration, 6 where $m=20$ Tones and $K=2.8 \times 10^6$ N/m.



Solution:

Given; Total $m = 3 \times 20\text{T} = 60\text{T} = 60000 \text{ kg}$

Equivalent spring constant $k = \frac{2.8 \times 10^6 \times 2.8 \times 10^6}{(2.8 \times 10^6) + (2.8 \times 10^6)} = 1400000 \text{ N/m}$

We know, Frequency $f = \frac{1}{2\pi} \sqrt{\frac{k}{m}} = \frac{1}{2\pi} \sqrt{\frac{1400000}{60000}} = 0.769 \text{ Hz (Answer)}$

(c) A compound of train consists of six gears. The number of teeth on each gear are as follows: 8

Gear	: A	B	C	D	E	F
No. of teeth	: 60	40	50	25	30	24

The gears B & C are on one shaft while the gears D & E are on the another shaft. The gear A drives B, gear c drives D, gear E drives F. If the gear A transmits 1.4kW at 100 rpm and the gear train has an efficiency Of 80% find the torque on gear F.

Solution:

Given;

$$P_A = 1.4 \text{kw}$$

$$N_A = 100 \text{rpm}$$

$$T_A = 60$$

$$T_B = 40$$

$$T_C = 50$$

$$T_D = 25$$

$$T_E = 30$$

$$T_F = 24$$

$$\text{Efficiency} = 80\% = 0.8$$

We know;

$$\frac{N_A}{N_B} \times \frac{N_C}{N_D} \times \frac{N_E}{N_F} = \frac{T_B}{T_A} \times \frac{T_D}{T_C} \times \frac{T_F}{T_E}$$

$$\frac{N_A}{N_F} = \frac{40 \times 25 \times 24}{60 \times 50 \times 30}$$

$$\frac{N_A}{N_F} = \frac{4}{15}$$

$$\therefore N_F = \frac{15N_A}{4} = 375 \text{rpm}$$

$$\text{Efficiency} = \frac{P_{\text{out}}}{P_{\text{in}}} = P_{\text{out}} = P_F = .8 \times 1.4 = 1.12 \text{kw} = 1120 \text{w}$$

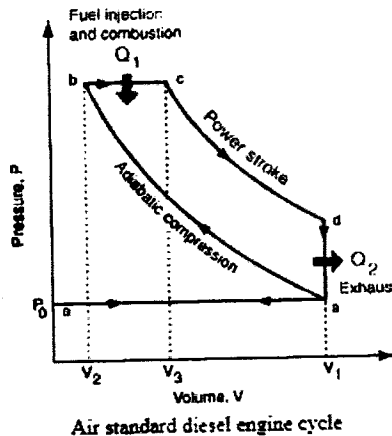
We know;

$$P_F = Tw = T \times \frac{2\pi N_F}{60}$$

$$\therefore T = 28.52 \text{ Nm (Answer)}$$

8. (a) A diesel engine has a compression ratio of 20 and cut-off takes place at 5% of the stroke. Find the air standard efficiency. Assume $\delta = 1.4$ 7

Solution:



$$\text{Compression ratio} = \frac{V_1}{V_2} = 20$$

$$\Rightarrow V_1 = 20 V_2$$

$$\text{Cut off ratio, } \rho = \frac{V_3}{V_2}$$

$$\text{Swept volume, } V_s = V_1 - V_2$$

$$\begin{aligned} \text{Cut off volume, } V_3 - V_2 &= 0.05 \times V_s \\ &= 0.05 \times (V_1 - V_2) \\ &= 0.05 \times (20V_2 - V_2) \\ &= 0.95 V_2 \end{aligned}$$

$$\text{So, } V_3 = 1.95 V_2$$

$$\text{Now, cut off ratio, } \rho = \frac{V_3}{V_2} = \frac{1.95 V_2}{V_2} = 1.95$$

Air standard diesel cycle efficiency,

$$\begin{aligned} \eta &= 1 - \frac{1}{r^{\gamma-1}} \left[\frac{\rho^{\gamma}-1}{\gamma(\rho-1)} \right] \\ &= 1 - \frac{1}{20^{1.4-1}} \left[\frac{1.95^{1.4}-1}{1.4(1.95-1)} \right] \\ &= 0.65 = 65\% \text{ (Answer)} \end{aligned}$$

(b) What are catalytic converter? How are they helpful in reducing HC, CO and NO_x emissions in engines? 5

Answer:

Catalytic converters (CAT) are designed to turn harmful constituents of exhaust emitted by internal combustion engines into harmless gases by means of a chemical reaction. A catalytic converter is therefore an important part of modern emission purification systems for SI and diesel engines.

Most modern cars are equipped with three-way catalytic converters. "Three-way" refers to the three regulated emissions it helps to reduce -- carbon monoxide, HC and NO_x molecules. The converter uses two different types of catalysts, a reduction catalyst and an oxidation catalyst. Both types consist of a ceramic structure coated with a metal catalyst,

usually platinum, rhodium and/or palladium. The idea is to create a structure that exposes the maximum surface area of catalyst to the exhaust stream, while also minimizing the amount of catalyst required (they are very expensive).

There are two main types of structures used in catalytic converters -- honeycomb and ceramic beads. Most cars today use a honeycomb structure.

The reduction catalyst is the first stage of the catalytic converter. It uses platinum and rhodium to help reduce the NO_x emissions. When an NO or NO_2 molecule contacts the catalyst, the catalyst rips the nitrogen atom out of the molecule and holds on to it, freeing the oxygen in the form of O_2 . The nitrogen atoms bond with other nitrogen atoms that are also stuck to the catalyst, forming N_2 . For example: $2\text{NO} \rightarrow \text{N}_2 + \text{O}_2$

The oxidation catalyst is the second stage of the catalytic converter. It reduces the unburned hydrocarbons and carbon monoxide by burning (oxidizing) them over a platinum and palladium catalyst. This catalyst aids the reaction of the CO and hydrocarbons with the remaining oxygen in the exhaust gas.

For example: $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$

(c) What is meant by abnormal combustion in SI engines? Explain the phenomena of knocking in SI engine? Summarize the variables affecting knock in such engines? 8

Answer: When the combustion gets deviated from the normal behavior resulting loss of performance or damage to the engine. It is happened when the charge inside the cylinder may be ignited before the flame front reaches it.

Knocking: It's a sudden combustion of the end gas ahead of the flame front due to increase in charge pressure and temperature higher than self-ignition conditions of the charge causing a pressure wave leading to a vibration of cylinder walls.

Factors affecting Detonation or Knocking in SI engine:

- 1. Compression ratio:** The pressure and temperature at the end of compression increase with the increase in compression ratio. This in turn increases the maximum pressure during the combustion and creates a tendency to knock.
- 2. Supercharging:** It is the process of allowing the charge at a pressure higher than atmospheric pressure. Because of supercharging the density and temperature increase thereby knocking tendency increases. Super charging is generally done on CI engines
- 3. Increasing inlet temperature:** It results in increase in knocking.
- 4. Increase in load:** Increase in load results in an increase in temperature of the cylinder, thereby raising the temperature and hence knocking tendency increasing at high loads.
- 5. Advancing the spark:** When the spark is advance the burning gas is compressed by rising piston and therefore the increase in temperature will be much more and hence the knocking tendency increases. To avoid detonation spark must be retarded.
- 6. Flame travel distance:** Flame travel distance should be small to avoid detonation.
- 7. Spark plug location:** spark plug which is located centrally has minimum tendency for knocking because the flame travel distance decreases.

8. Engine size: For larger engine size the flame travel distance will be longer and hence knocking chances are high, because of this reason SI engine sizes are generally limited

9. Location of exhaust valve: There are two hot spot zones in SI engines. ie., spark plug & exhaust valve. If the exhaust valve is very far from the spark plug the temperature around the exhaust valve region will be high. If the spark plug is very far it will take much time and during this time the charge near the exhaust valve would autoignite due to high temperature and hence exhaust valve must be located as close to the spark plug as possible. So the flame travel distance is minimized.

10. Turbulence: With the increase in turbulence the flame speed increases and hence the chances of detonation would decrease.

11. Engine speed: Increase in engine speed increases turbulence as hence knocking tendency decreases.

12. Octane rating of fuel: For better antiknock properties octane number must be high.

9. (a) Briefly describe the working principle in hybrid vehicle.

7

Answer: Hybrid electric vehicles are powered by an internal combustion engine and an electric motor, which uses energy stored in batteries. A hybrid electric vehicle cannot be plugged in to charge the battery. Instead, the battery is charged through regenerative braking and by the internal combustion engine. The extra power provided by the electric motor can potentially allow for a smaller engine. The battery can also power auxiliary loads and reduce engine idling when stopped. Together, these features result in better fuel economy without sacrificing performance.

A hybrid vehicle works with the following components:

Battery (auxiliary): In an electric drive vehicle, the auxiliary battery provides electricity to start the car before the traction battery is engaged and also powers vehicle accessories.

DC/DC converter: This device converts higher-voltage DC power from the traction battery pack to the lower-voltage DC power needed to run vehicle accessories and recharge the auxiliary battery.

Electric generator: Generates electricity from the rotating wheels while braking, transferring that energy back to the traction battery pack. Some vehicles use motor generators that perform both the drive and regeneration functions.

Electric traction motor: Using power from the traction battery pack, this motor drives the vehicle's wheels. Some vehicles use motor generators that perform both the drive and regeneration functions.

Exhaust system: The exhaust system channels the exhaust gases from the engine out through the tailpipe. A three-way catalyst is designed to reduce engine-out emissions within the exhaust system.

Fuel filler: A nozzle from a fuel dispenser attaches to the receptacle on the vehicle to fill the tank.

Fuel tank (gasoline): This tank stores gasoline on board the vehicle until it's needed by the engine.

Internal combustion engine (spark-ignited): In this configuration, fuel is injected into either the intake manifold or the combustion chamber, where it is combined with air, and the air/fuel mixture is ignited by the spark from a spark plug.

Power electronics controller: This unit manages the flow of electrical energy delivered by the traction battery, controlling the speed of the electric traction motor and the torque it produces.

Thermal system (cooling): This system maintains a proper operating temperature range of the engine, electric motor, power electronics, and other components.

Traction battery pack: Stores electricity for use by the electric traction motor.

Transmission: The transmission transfers mechanical power from the engine and/or electric traction motor to drive the wheels.

(b) How does a telescope shock-absorber works in an automobile? Briefly describe with neat sketch. 8

Answer: A telescopic shock absorber (damper) can be compressed and extended; the so called bump stroke and rebound stroke. Telescopic shock absorbers can be subdivided in:

- Bi-tube, or twin-tube dampers, available in hydraulic and gas-hydraulic configuration.
- Mono-tube dampers, also called high pressure gas shocks.

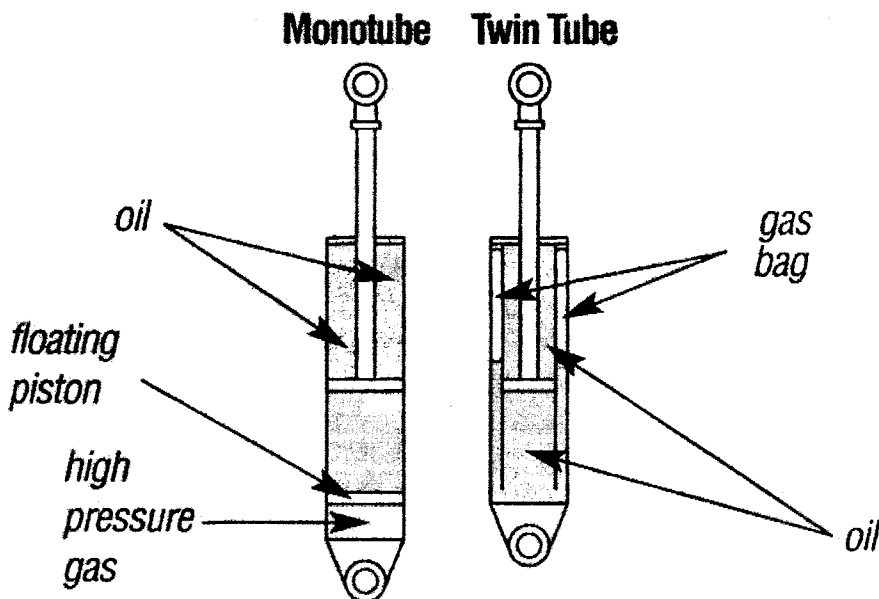


Figure: Telescope shock-absorber

Working of bi-tube shock absorber:

Bump stroke: When the piston rod is pushed in, oil flows without resistance from below the piston through the orifices and the non-return valve to the enlarged volume above the piston. Simultaneously, a quantity of oil is displaced by the volume of the rod entering the cylinder. This volume of oil is forced to flow through the bottom valve into the reservoir tube (filled with air (1 bar) or nitrogen gas (4-8 bar)). The resistance, encountered by the oil on passing through the foot valve, generates the bump damping.

Rebound stroke: When the piston rod is pulled out, the oil above the piston is pressurized and forced to flow through the piston. The resistance, encountered by the oil on passing through the piston, generates the rebound damping. Simultaneously, some oil

flows back, without resistance, from the reservoir tube through the foot valve to the lower part of the cylinder to compensate for the volume of the piston rod emerging from the cylinder.

The main components are:

- Outer tube, also called reservoir tube
- Inner tube, also called cylinder
- Piston connected to a piston rod
- Bottom valve, also called foot valve
- Piston rod guide
- Upper and lower attachment

Working of mono-tube shock absorber:

Bump stroke

Unlike the bi-tube damper, the mono-tube shock has no reservoir tube. Still, a possibility is needed to store the oil that is displaced by the rod when entering the cylinder. This is achieved by making the oil capacity of the cylinder adaptable. Therefore the cylinder is not completely filled with oil; the lower part contains (nitrogen) gas under 20 – 30 bar. Gas and oil are separated by the floating piston (2)

When the piston rod is pushed in, the floating piston is also forced down by the displacement of the piston rod, thus slightly increasing pressure in both gas and oil section. Also, the oil below the piston is forced to flow through the piston. The resistance encountered in this manner generates the bump damping.

Rebound stroke

When the piston rod is pulled out, the oil between piston and guide is forced to flow through the piston. The resistance encountered in this manner generates the rebound damping. At the same time, part of the piston rod will emerge from the cylinder and the free (floating) piston will move upwards.

The main components are:

- (pressure) cylinder, also called working cylinder
- Piston connected to a piston rod
- Floating piston, also called separating piston
- Piston rod guide
- Upper and lower attachment

(c) What are the functions of an oil ring used in engine cylinder?

5

Answer: An oil ring is the piston ring located in the ring groove closest to the crankcase. The oil ring is used to wipe excess oil from the cylinder wall during piston movement. Excess oil is returned through ring openings to the oil reservoir in the engine block.

An oil ring includes two thin rails or running surfaces. Holes or slots cut into the radial center of the ring allow the flow of excess oil back to the oil reservoir. Oil rings are commonly one piece, incorporating all of these features. Some on-piece oil rings utilize a spring expander to apply additional radial pressure to the piston ring. This increases the unit (measured amount of force and running surface size) pressure applied at the cylinder wall.

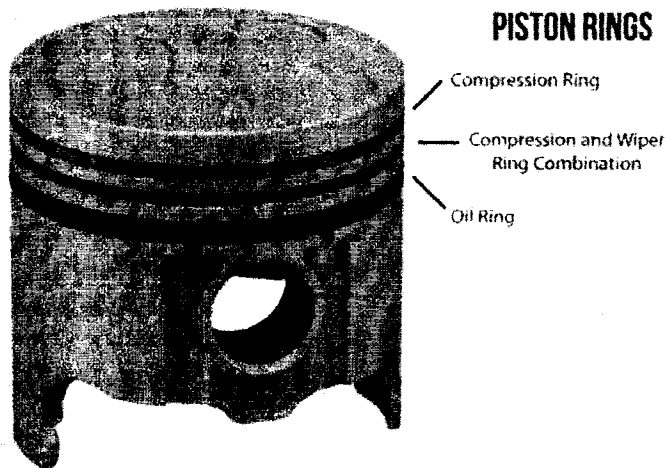


Figure: Oil ring

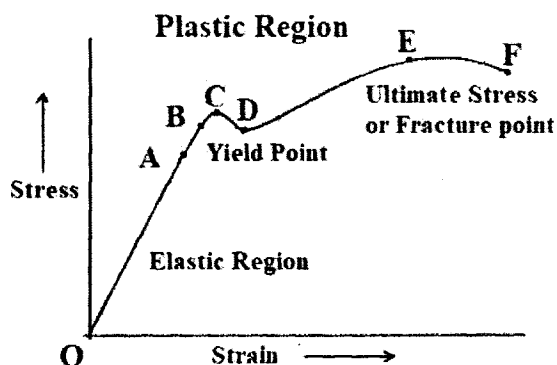
The oil ring has the highest inherent pressure of the three rings on the piston. Some Briggs & Stratton engines use a tree-piece oil ring consisting of two rails and an expander. The oil rings are located on each side of the expander. The expander usually contains multiple slots or windows to return oil to the piston ring groove. The oil ring uses inherent piston ring pressure, expander pressure, and the high unit pressure provided by the small running surface of the thin rails.

Oil ring performs multiple functions:

- Wipes the oil from the cylinder walls as the piston moves down
- Separates the combustion chamber and oil chamber and prevents the leakage of pressure in combustion chamber

10. (a) Describe the stress strain curve of a ductile material and identify of all the important parameters. 7

If a ductile bar of uniform cross-sectional area is subjected to gradually increasing axial tensile force (generally is done in Universal Testing Machine) till failure of the bar occurs, when the stress-strain curve plots the curve may be divided into following parts:



Stress-Strain Curve for Ductile Materials

Portion OA: This portion is absolutely straight, where the stress is proportional to strain and the material obeys Hooke's law ($\sigma = E \epsilon$). The value of stress at point A is called proportional limit.

Portion AB: In this portion, Hook's law is not obeyed, although the material may still be elastic. The point B indicates the elastic limit.

Portion BC: In this portion, the metal shows a strain even without increase in stress and the strain is not fully return when load is removed.

Portion CD: Yielding start in this portion and there is a drop of stress at the point D directly after yielding begins at C. The point D is termed as lower yield point and C is called upper yield point.

Portion DE: After yielding has taken place at D, further straining takes place at this portion by increasing the stress and the stress-strain curve continues to rise up to the point E. Strain in this portion is about 100 times that of portion O-A. At the point E, the bar begins to form a local neck. The point E is termed as ultimate tensile stress point.

Portion EF: In this portion, the load is falling off from the maximum and fracture at F takes place. The point F is termed as fracture or breaking point and the identical stress is called breaking stress.

(b) Find the horsepower transmitted by a belt running over a pulley of 60 cm diameter at 200 rpm. The coefficient of friction between the pulley and belt is 0.25 angle of lap 160° and maximum tension in the belt is 250 kg. 7

Solution: Pulley diameter = 60 cm = 0.60 m, Speed, N = 200 rpm,

$$V = \frac{\pi \times d \times N}{60} = \frac{\pi \times 0.60 \times 200}{60} = 6.283 \text{ m/s}$$

Coefficient of friction between the pulley and belt, $\mu = 0.25$

$$\text{Angle of lap, } \theta = 160^\circ = \frac{\pi \times 160}{180} \text{ radian} = 2.79 \text{ radian}$$

$$\text{Max tension, } T_1 = 250 \text{ kg} = 250 \times 9.8 \text{ N} = 2450 \text{ N}$$

$$\text{We know, } \frac{T_1}{T_2} = e^{\mu \theta}$$

$$\Rightarrow \frac{2450}{T_2} = e^{0.25 \times 2.79}$$

$$\Rightarrow T_2 = 1219.68 \text{ N}$$

$$\therefore P = (T_1 - T_2) \times v = 7730.10 \text{ W} = (7730.10/746) \text{ HP} = 10.36 \text{ HP (Answer)}$$

(c) Write short notes on addendum and dedendum and module for a spur gear. 6

Answer: Addendum: The addendum is the height by which a tooth of a gear projects beyond (outside for external, or inside for internal) the standard pitch circle or pitch line; also, the radial distance between the pitch diameter and the outside diameter.

Dedendum: It is the distance between the dedendum circle and pitch circle of a gear wheel or rack.

Module: "Module" is the unit of size that indicates how big or small a gear is. It is the ratio of the reference diameter of the gear divided by the number of teeth.

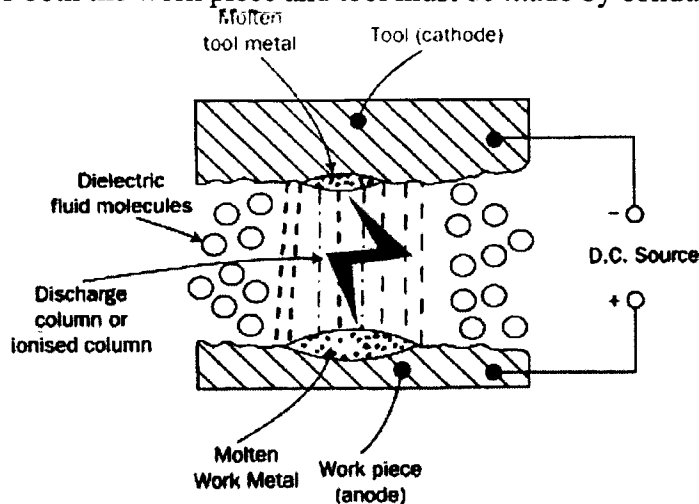
11.(a) Briefly describe the working principle of an electro discharge machine (EDM). 7

Answer: Electro discharge machining is a process in which electrical energy is used to

generate the Spark between the tool and workpiece submerged under the dielectric medium so that material removal takes place from the surface of the work piece by local melting or vaporization.

Working Principle:

Electrical discharge machining process works on the basic principle of spark generation and metal removed by spark erosion. EDM spark erosion is same as electric spark which burn a small hole in a piece of metal through which it contacts. The spark generated by this process produces heat, which remove metal by erosion and evaporation. In this machining process both the work piece and tool must be made by conductive material.



(b) What are the basic difference between 'hot working' and 'cold working' of metal processing? 6

Cold working	Hot working
It is done at a temperature below the recrystallization temperature.	Hot working is done at a temperature above recrystallization temperature
It is done below recrystallization temperature so it is accomplished by strain hardening.	Hardening due to plastic deformation is completely eliminated.
Crystallization does not take place	Crystallization takes place
Material is not uniform after this working	Material is uniform though
There is more risk of cracks	There is less risk of cracks
Cold working increases ultimate tensile strength, yield point hardness and fatigue strength but decreases resistance to corrosion.	In hot working, ultimate tensile strength, yield point, corrosion resistance are unaffected
Internal and residual stresses are produced	Internal and residual stresses are not produced
Cold working required more energy for plastic deformation	It requires less energy for plastic deformation because at higher

	temperature metal become more ductile and soft.
It does not require pickling because no oxidation of metal takes place	Heavy oxidation occurs during hot working so pickling is required to remove oxide.

(c) Explain the TIG and MIG welding processes giving application of each.

7

TIG Welding:

In Tungsten inert gas(TIG) welding the heat is produced from an arc between the non-consumable tungsten electrode and work piece. The welding zone is shielded by an atmosphere of inert gas supplied from a suitable source. The direct current with straight polarity is used for welding copper alloys and stainless steel, whereas the reversed polarity is used for magnesium. The altering current is more versatile in welding for steel, cast iron, aluminium and magnesium.

Applications:

- Aerospace and aircraft construction
- Automotive industry
- Auto body repairs

MIG Welding:

MIG or metal inert gas welding is a welding method that uses an electric arc to create welds. However, MIG uses a continuous solid wire electrode, which is heated and fed into the weld pool from a welding gun. The two base materials are melted together, forming a join. In MIG welding, the melted electrode facilitates the joining of the two metals. Hence, MIG is ideal for joining dissimilar metals. Shielding gas is also supplied through the weld gun to ensure that the weld pool does not interact with the air, oxidizing the weld area.

Applications:

- Used for most types of sheet metal welding
- Fabrication of pressure vessels and steel structures
- Automotive industry and home improvement industry.

12.(a) State the central limit theorem. Describe the properties of a good estimator?

7

Central limit theorem: In Probability, the central limit theorem states that the distribution of sample approximate a normal distribution (also known as bell curve) as the sample size becomes larger, assuming that all samples are identical in size, and regardless of the population distribution shape.

Properties of good estimator: There are four desirable properties every good estimator should possess;

1. Unbiasedness: An Estimator is said to be unbiased if its expected value is identical with the population parameter being estimated. That is if θ is an unbiased estimate of θ , then we must have $E(\theta) = \theta$. Many estimators are asymptotically unbiased in the sense

that the biases reduce to practically insignificant value when n becomes sufficiently large. It should be noted that bias estimation is not necessarily undesirable. It may turn out to be an asset in some situations.

Consistency: If an estimator, say θ , approaches the parameter θ closer and closer as the sample size n increases, θ is said to be consistent estimator of θ . Stating somewhat more rigorously, the estimator θ is said to be consistent estimator of θ if as, n approaches infinity, the probability approaches 1 that θ will differ from the parameter θ by no more than an arbitrary constant.

Efficiency: The concept of efficiency refers to the sampling variability of an estimator. If two competing estimators are both unbiased, the one with the smaller variance (for a given sample size) is said to be relatively more efficient.

Sufficiency: An estimator is said to be sufficient, if it conveys much information as is possible about the parameter which is contained in the sample. The significance of sufficiency lies in the fact that if a sufficient estimator exists, it is unnecessarily considered to any other estimator.

(b) What is work sampling? Explain the underlying principle on which it is based. Differentiate it from time study. 7

Work sampling: Work Sampling (also sometimes called ratio delay study) is a technique of getting facts about utilization of machines or human beings through a large number of instantaneous observations taken at random time intervals. The ratio of observations of a given activity to the total observations approximates the percentage of time that the process is in that state of activity. For example, if 500 instantaneous observations taken at random intervals over a few weeks show that a lathe operator was doing productive work in 365 observations and in the remaining 135 observations he was found 'idle' for miscellaneous reasons, then it can be reliably taken that the operator remains idle $(135/500) \times 100 = 27\%$ of the time. Obviously, the accuracy of the result depends on the number of observations. However, in most applications there is usually a limit beyond which greater accuracy of data is not economically worthwhile.

Principle/Theory of Work sampling:

It states that the percentage of observations recorded on an operation/process in any state is a reliable estimate of the percentage time the operation/process is in that state, provided, "sufficient number of observations is taken at random".

It may be noted that here, particular stress should be paid on the words "random" and "sufficient number of observations". In this technique, some error may occur but the magnitude of error tends to decrease as the number of samples increases.

Work sampling is a sampling method and depends upon the laws of probability. A sample taken at random from a large population provides a good estimate of the distribution of the population.

Work sampling	Time study
Work sampling is the statistical technique used for determining the proportion of time spent by workers in various defined categories of activity (setting up a machine, assembling two parts, idle...etc.).	It is a technique which is originated by Tayllor, was used mainly for determining the time standards or determining the standards time to perform a specific work.
Cheaper.	Costlier than work sampling.
Observer doesn't require much training.	Observer requires much training.
Statistical approach is difficult to understand by workers.	Statistical approach is easy to understand by worker.
The work sampling may be interrupted at any time without affecting the result.	The time study may not be interrupted at any time without affecting the result.

(c) What is control firm? What factors does a firm take into consideration when determining the operations to be controlled by control charts for variables?

The control charts for sample averages and ranges are called "control charts for variables." This is because they provide the firm with a method for controlling the value of a variable characteristic of a product. Once the charts have been constructed, they are used to control the quality of the output in the manner outlined earlier. Periodic samples would be taken, and the average and range of each sample would be plotted on the respective charts. Samples would have to be of uniform size if we want to maintain constant control limits, since the position of the limits is affected by the sample size. The individual sample averages and ranges would be plotted in the order in which the corresponding samples are drawn by using the central line as a time axis. This permits the analyst to approximate the time at which an out-of-control condition arose, and this may be useful in determining the cause of the variation.

37th BCS

Subject Code: 901

Time Allowed—4 hours

Full Marks—200

দ্রষ্টব্য- প্রশ্নের উত্তর ইংরেজী অথবা বাংলা যেকোন একটি ভাষায় দিতে হবে। তবে টেকনিক্যাল শব্দগুলো ইংরেজিতে লেখা চলবে। পার্ট-১ থেকে ১নং প্রশ্নের যে কোন পাঁচটি এবং পার্ট-২ থেকে ৮নং প্রশ্নসহ যেকোন পাঁচটি প্রশ্নের উত্তর দিতে হবে। প্রত্যেক প্রশ্নের মান প্রশ্নের শেষ প্রান্তে দেখানো হয়েছে।

Part-I**1. Write short notes with necessary sketch (Any Four)****4×5**

- (a) Flow Measuring Instrument
- (b) Vapor Compression Refrigeration System
- (c) Shear Force and Bending Moment Diagram of cantilever beam with gradually varying load
- (d) Submersible Pump
- (e) Heat Pump
- (f) Induced Draft

=20**Answer:**

- (a) Flow measuring instruments are (from “Fundamental of ME”; (3-7))
- (b) from “Fundamentals of Mechanical Engineering Vol.1, Chap.-6.”
- (c)) from “Fundamentals of Mechanical Engineering Vol.1, Chap.-7.”
- (d) 38th BCS (5-b)
- (e) 38th BCS (5-c)
- (f) 38th BCS (5-d)

2. (a) What is fixed Beam?**2**

Fixed beam: A beam whose both ends are fixed, is known as fixed beam.

(b) Describe the followings:**3×3=9****(i) Thermal Stress****(ii) Hoop Stress****(iii) Bearing Stress**

Thermal stress: When the external force applied on a body which leads to any sort of deformity is caused due to change in temperature, the resultant stress thus created can be termed as thermal stress.

Example: A common example of thermal stress is gap maintained between the inner and outer ends of rail track.

$$\delta_T = L\alpha\Delta T$$

Where,

L is length in meter

ΔT = Change in temperature °C

α = Coefficient of thermal expansion /°C

Hoop stress: The hoop stress, or tangential stress, is the stress around the circumference of the pipe due to a pressure gradient. The maximum hoop stress always occurs at the inner radius or the outer radius depending on the direction of the pressure gradient

Bearing stress: Bearing stress is a contact pressure between separate bodies.

(c) Find the thickness of the metal necessary for a steel cylindrical shell of internal diameter of 15cm to withstand an internal pressure of 500kg/cm². The maximum hoop stress in the section is not to exceed 1500kg/cm². 9

Solution: Given,

Diameter of cylindrical shell, $D = 15\text{cm}$

Internal pressure, $p = 500\text{kg/cm}^2$

Maximum hoop stress, $\sigma_t = 1500\text{kg/cm}^2$

To find the thickness of the metal, t

We know,

$$\sigma_t = \frac{pD}{2t}$$

$$\Rightarrow t = \frac{pD}{2\sigma_t}$$

$$\Rightarrow t = \frac{500 \times 15}{2 \times 1500} = 2.5\text{cm (Answer)}$$

3.(a) Define a Steam Boiler. 2

Steam Boiler: A steam boiler is a closed vessel, generally made of steel, in which water is heated by some source of heat produced by combustion of fuel and ultimately to generate steam.

(b) Name the “Boiler Accessories” which assist in increasing the thermal efficiency of the boiler. 4

“Fundamentals of Mechanical Engineering Vol.1, Chap.-1.”

(c) What are the advantages of “Water Tube Boiler” over “Fire Tube Boiler”? 5

1. Steam can be raised more quickly: In water tube boilers, the ratio of water content to the steam capacity is comparatively less than the fire tube boiler. Hence water tube boiler can quickly generate steam at the required pressure than the fire tube boiler.

2. Steam at higher pressures can be produced: The water tube boilers do not contain any tubes inside the boiler drum. Hence the water tube boilers can withstand high pressures for the same wall thickness and the thermal stresses. Therefore water tube boilers can develop higher pressures than the fire tube boilers.

3. Higher rate of evaporation: In water tube boilers, water is contained in a large number of small diameter tubes; therefore the heating surface of a water tube boiler is more than that of the fire tube boiler. The relatively large heating surface of the water tube boiler increases the evaporation rate. The increased rate of evaporation of the water tube boiler makes it more suitable for large power plants.

4. Sediment deposition is less: In water tube boilers, the circulation of water is more positive than that of the fire tube boilers; hence there is a less tendency of the deposits to settle on the heating surfaces. This positive circulation also helps the quick generation of steam than the fire tube boiler.

5. Suitable for any type of fuel and method of firing: Since the water tube boilers are

externally fired, the size and proportions of the furnace can be altered to suit any type of fuel and the method of firing which is not possible in the case of fire tube boilers.

6. More effective heat transfer: The heat transfer in the water tube boilers is more effective than the fire tube boilers since the hot gases flow at right angles to the water tubes.

7. Failure of water tubes will not affect the working of boiler: Bursting of any of the water tubes does not pose any serious problems, whereas the bursting any of the fire tubes causes serious problems in fire tube boilers.

8. Occupies less Space: For a given power, water tube boiler occupies less space than that of the fire tube boilers.

9. Easy maintenance: All parts of the water tube boilers are easily accessible compared to, the fire tube boilers, for cleaning, repairing and inspection and hence maintenance is easy.

10. Easy transportation: Water tube boilers can be easily dismantled, conveniently transported and erected quickly at the site than a fire tube boiler.

(d) Mention the factors which are to be considered while selecting the "Boiler"? 4

Answer:

The selection of type and size of a steam boiler depends upon the following factors:

1. The power required and working pressure.
2. The rate at which the steam is to be generated.
3. The geographical position of the power house.
4. The fuel and water available.
5. The type of fuel to be used
6. The probable permanency of the station.
7. The probable load factor.

(e) Mention the methods of "Feed Water Treatment" in case of boiler. 5

Answer: The methods employed generally may be summarized as follows:

1. Sedimentation
2. Filtration
3. Lime-soda softening (cold process)
4. Lime-soda softening (hot process)
5. Zeolite softening
6. De-concentration
7. Degassing
8. Evaporation
9. Boiler compounds

4. (a) Define "Fit". 2

Fit: Fit is defined as a degree of tightness or looseness between two mating parts to perform definite function when they are assembled together. The nature of fit is characterized by the presence and size of clearance and interference.

(b) Describe three types of "Fit". 6

1. Clearance Fit: In this type of fit the shaft diameter is always less than the hole

diameter. For any hole and shaft assembly, if the upper limit size of the shaft is less than the lower limit size of the hole then that type of fit is known as clearance fit. Shaft can freely slide or rotate in the hole. Force is not required for this fit.

2. Transition Fit: If the maximum hole size is greater than smaller size of shaft or minimum hole size is lesser than maximum size of shaft, such type is called transition fit. This type of fit lies midway between clearance fit and interference fit and it may sometimes provide clearance fit and sometimes interference fit. For may or may not be required.

3. Interference Fit: In this type of fit the minimum diameter of the shaft is always greater than the maximum diameter of the hole. There is no relative motion between shaft and hole. Force is required for this fit (either heating the hole or freeing the shaft).

(c) What is meant by “hole basis” and “shaft basis” and which one is preferred and why? 6

Hole basis: In hole basis system the hole is kept as the constant and the shaft upper and lower deviation values determine the type of fit. In hole basis system the Lower deviation of the hole will be zero.

Shaft basis: In Shaft basis system the shaft is kept as the constant and hole upper and lower deviation values determine the type of fit. In shaft basis system the upper deviation of the shaft will be zero.

Which one is preferred?

Hole basis system is preferred over shaft basis system.

Why?

This is because the holes are usually produced and finished by standard tooling like drill, reamers, etc., whose size is not adjustable easily. On the other hand, the size of the shaft (which is to go into the hole) can be easily adjusted and is obtained by turning or grinding operations.

(d) Mention different types of “Power Threads”. Discuss their relative advantages and disadvantages.

Types of power Threads:

1. Square Thread
2. Trapezoidal Thread
3. Buttress Thread

Advantage of square thread:

- 1) Efficiency of sq. threads is more than trapezoidal threads
- 2) There is no side thrust or radial pressure.

Disadvantages of square thread:

- 1) Square threads are difficult to manufacture than trapezoidal threads.
- 2) The wear of square threads cannot be compensated as it can be done in trapezoidal.
- 3) The thread thickness at core is less than trapezoidal, hence square threads have less load carrying capacity.

Advantages of Trapezoidal thread:

- 1) Stronger than square threads
- 2) Easy to manufacture

3) Wear compensation

Disadvantages of Trapezoidal thread:

- 1) Efficiency less than square thread.
- 2) There is a side thrust.

Advantages of Buttress Thread:

- 1) Can bear very heavy load in one direction
- 2) Increased clamping speed
- 3) Lower number of threads per axial distance
- 4) High thread strength in one direction
- 5) Greatest thread shear capacity.

Disadvantages of Buttress Thread:

- 1) Only designed to be loaded in one direction.

5. (a) Define: Thermal Conductivity and Thermal Diffusivity. What are the significance of their numbers? 8

Thermal conductivity: Thermal conductivity of a material is numerically equal to the quantity of heat which flows in one second through a slab of the material of unit area and unit thickness when its faces differ in temperature by 1K.

Significance: Increased thermal conductivity allows for a faster rate of heat transfer in phase change material (PCM), reducing the time required for the PCM to undergo a complete charge or discharge. Thermal conductivity is the intrinsic property of a material that expresses its ability to conduct heat.

Thermal Diffusivity: It is the Thermal conductivity divided by density and specific heat capacity at constant pressure.

Significance:

Thermal diffusivity gives a measure of how quickly the temperature will change when it is heated or cooled. Materials with a high thermal diffusivity will heat or cool quickly; conversely, substances with a low thermal diffusivity will heat or cool slowly.

(b) An exterior wall of a house may be approximated by a 4cm layer of common brick ($k=0.17\text{w/m.k}$) followed by a 3cm layer of gypsum plaster ($k=0.48\text{w/m.k}$). What thickness of loosely packed rock wool insulation ($k=0.065\text{ w/m.k}$) should be added to reduce the heat loss through the wall by 80%? 12

Solution: Given;

Brick layer $x_b = 4\text{cm} = 0.04\text{m}$ and conductivity of brick $k_b = 0.17\text{ w/mk}$

Layer of Gypsum plaster $x_g = 3\text{cm} = 0.03\text{m}$ and conductivity $k_g = 0.48\text{ w/mk}$

Conductivity of rock wool insulation $k_w = 0.065\text{ w/mk}$ and thickness $x_w = ?$

Let, the temperature difference between two sides of wall = $T_1 - T_2$

Now for without rock wool insulation;

$$Q = \frac{T_1 - T_2}{\frac{x_b}{k_b A} + \frac{x_g}{k_g A}} = A(T_1 - T_2) \frac{1}{\frac{0.04}{0.17} + \frac{0.03}{0.48}} = 3.358A(T_1 - T_2)$$

For with rock insulation;

$$\text{Heat transfer} = (1 - 0.8)Q = 0.2Q$$

$$\Rightarrow 0.2Q = \frac{T_1 - T_2}{\frac{x_b}{k_b A} + \frac{x_g}{k_g A} + \frac{x_w}{k_w A}}$$

$$\Rightarrow 0.2 \times 3.358A(T_1 - T_2) = A(T_1 - T_2) \frac{1}{\frac{0.04}{0.17} + \frac{0.03}{0.48} + \frac{x_w}{0.065}}$$

$$\therefore x_w = 0.0774\text{m} = 7.74\text{cm (Answer)}$$

6. (a) Put forward the mathematical form of steady flow equation. Show the application of it to the following engineering system: (i)Boiler (ii)Compressor (iii)Turbine

Answer:

Steady flow energy equation is $\dot{Q} + \dot{W} = \dot{m}(h_2 - h_1)$

(i) Boiler: $\dot{Q} = \dot{m}(h_2 - h_1)$; [Hence $\dot{W} = 0$]

(ii) Compressor: $\dot{W} = \dot{m}(h_2 - h_1)$; [Hence $\dot{Q} = 0$]

Here, $h_2 > h_1$ because work is done on the system; So, \dot{W} is positive.

(iii) Turbine: $\dot{W} = \dot{m}(h_2 - h_1)$; [Hence $\dot{Q} = 0$]

Here, $h_2 < h_1$ because turbine works on the surroundings; So, \dot{W} is negative.

(b) Why is “Reciprocating Pump” called a positive displacement pump? 6

Explain the terms “Slip” and “Cavitation” with reference to reciprocating pumps. Also mention the condition of “negative slip”.

Answer:

The ‘positive displacement’ pumps are those pumps in which the liquid is sucked and then it is actually pushed or displaced due to the thrust exerted on it by a moving member, which results in lifting the liquid to the required height. These pumps usually have one or more chambers which are alternately filled with the liquid to be pumped and then emptied again. As such the discharge of liquid pumped by these pumps almost wholly depends on the speed of the pump. The most common example of the positive displacement type of pumps is that of reciprocating pumps.

Slip: + Cavitation+ Negative slips: “Fundamentals of Mechanical Engineering Vol.1, Chap.-3.”

(c) What are the relative advantages if using a “venture meter” to measure flow compared with using an orifice meter? 5

Answer: Advantages of venturi meter:

- Less chance of getting stuck with sediment.
- The discharge coefficient is high.
- Its behavior can be predicted perfectly.
- It can be installed vertically, horizontally, inclined.
- They are more precise and can be used for a wide range of flows.
- About 90% of the pressure drop can be recovered.

Disadvantages of orifice meter:

- Requires homogeneous fluid.
- Requires single phase liquid
- It requires the flow of axial velocity vectors.
- It causes a pressure drop in the fluid.
- Its accuracy is affected by the density, pressure and viscosity of the fluid.
- The range of measurement of viscosity limits of fluids.
- It requires straight conduits to ensure accuracy is maintained.
- The pipe must be totally special for the measurement of the flow of liquids.
- They have low range capacity.

7. (a) Discuss your concept on theories of “Failure”. Give a brief concept on maximum stress theory and maximum shear theory.

6

Various theories of failure have been proposed, their propose being to establish, from the behavior of a material subjected to simple tension or compression tests, the point at which failure will occur under any type of combined loading. By failure it is meant either yielding or actual rupture whichever occurs first.

Practically yielding begins at the yield strength at which plastic deformation becomes significant. When several components of stress occur, yielding depends on some combination of these components. Various theories of failure are:

- The maximum stress theory
- The maximum strain theory
- The maximum shear theory
- The Mises yield theory

Maximum stress theory: The maximum stress theory proposed by Rankine is the oldest as well as the simplest of all the theories. It is based on the assumption that failure occurs when the maximum principal stress on an element reaches a limiting value, the limit being the yield point in a simple tension test. The theory disregards the effect of possible other principal stresses and the shearing stresses on other planes through the element.

Maximum shear theory: Sometimes called Guest’s theory, the maximum shear theory assumes that yielding begins when the maximum shearing stress equals the maximum shearing stress developed at yielding in simple tension. Since the maximum shearing stress is equal to one-half the difference between the principal stresses, the condition for yielding is

$$\tau_w = \frac{1}{2}(\sigma_{\max} - \sigma_{\min}) = \frac{1}{2}\sigma_{yp}$$

(b) Why is flywheel used in IC Engine? Explain the turning moment diagram of a four stroke cycle IC Engine.

7

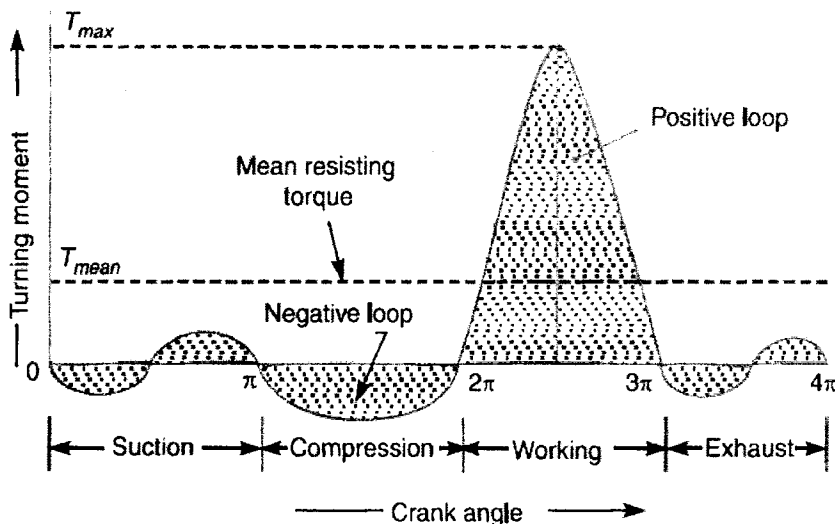
Answer: Flywheel controls the speed variation caused by the fluctuation of the engine

turning moment during each cycle of operation.

Flywheel acts like an energy reservoir. It stores energy when supplied energy is higher than required energy. On the other hand it releases the stored energy when supplied energy is less than required energy. As a result the crankshaft rotates at a uniform speed. The flywheel does not maintain a constant speed. It just reduces the fluctuation of speed. It also prevents jerk of crankshaft.

Turning moment diagram of four stroke cycle IC Engine:

A turning moment diagram of four stroke cycle internal combustion engine is shown in the following figure.



In a four stroke cycle internal combustion engine there is one working stroke after the crank has turned through two revolutions. Since the pressure inside the engine cylinder is less than the atmospheric pressure during the suction stroke, therefore a negative loop is formed. During the compression stroke the work is done on the gases, therefore a higher negative loop is obtained. During the expansion stroke the fuel burns and the gases expand, therefore a large positive loop is obtained. In this stroke the work is done by the gases. During exhaust stroke the work is done on the gases, therefore a negative loop is formed.

(c) What should be properties of an ideal refrigerant?

7

Properties of ideal refrigerant is given below:

- Low freezing point
- Low condensing pressure
- High critical pressure
- High vapor density
- High dielectric strength
- High latent heat of vaporization

- High heat transfer coefficient
- Non-toxic
- Non-reactive
- Non-flammable
- Low water solubility.

8. Describe briefly (Any Five)**4×5=20****(a) Acceptance sampling****(b) Cetane Number****(c) Spindle****(d) Die Casting****(e) Motivation****(f) Sensing Elements****(g) MIG Welding****(h) Damped Vibration**

a) Acceptance Sampling: Acceptance sampling is a statistical measure used in quality control. It allows a company to determine the quality of a batch of products by selecting a specified number for testing. The quality of this designated sample will be viewed as the quality level for the entire group of products.

A company cannot test every one of its products. There may simply be too high a volume or number of them to inspect at a reasonable cost or within a reasonable time frame. Or effective testing might result in the destruction of the product or making it unfit for sale in some way. Acceptance sampling solves these problems by testing a representative sample of the product for defects. The process involves first, determining the size of a product lot to be tested, then the number of products to be sampled, and finally the number of defects acceptable within the sample batch. Products are chosen at random for sampling.

b) Cetane Number: Cetane number of a fuel is defined as the percentage by volume of normal cetane($C_{16}H_{34}$) in a mixture of normal cetane and α methyl naphthalene($C_{11}H_{10}$) which have the same ignition characteristics(ignition delay) as the test fuel when combustion is carried out in a standard engine under specified operating condition.

Characteristics:

- Cetane number denotes how fast the fuel will auto ignite.
- The higher the cetane number the lower the tendency of knocking
- Cetane number of diesel 40-60.

c) Spindle: A spindle is a rotating shaft with a fixture for holding a tool (in the case of a milling, grinding, or drilling spindle) or a work piece (in the case of a turning spindle). The spindle shaft serves as a support, a positioner, and a rotary drive for the tool or work piece. The spindle shaft must take up any machining forces arising during cutting with the lowest possible deformation response, generate/transmit the cutting power provided by an internal or external drive for machining, and exhibit high positioning and running accuracy. In machine tools, various types of main spindles are used to satisfy different requirements. Turning and grinding spindles must achieve extremely high concentricity at a high stiffness and usually medium speeds, whereas milling and drilling spindles are

used at (in part) high speeds under changing operating conditions.

d) Die Casting: Die casting is a manufacturing process for producing accurately dimensioned, sharply defined, smooth or textured-surface metal parts. It is accomplished by forcing molten metal under high pressure into reusable metal dies. The process is often described as the shortest distance between raw material and finished product. Die casting is one of the most economical and quickest forming processes. The advantages of this production process are that hundreds of thousands of castings can be produced relatively quickly by using just one mold. All components produced have a uniform quality and involve relatively low unit costs.

e) Motivation: Motivation refers to the forces that simulate a person's enthusiasm and persistence to pursue a certain course of action. Having knowledge of motivation is important.

- It helps to understand what prompts people to initiate action.
- It helps to understand what influence the choice of action of the people.
- It helps to know why people persist in any action over time.

f) Sensing Elements: A sensor is a device that detects and responds to some type of input from the physical environment. The specific input could be light, heat, motion, moisture, pressure, or any one of a great number of other environmental phenomena. The output is generally a signal that is converted to human-readable display at the sensor location or transmitted electronically over a network for reading or further processing.

Example- Motion sensors in various systems including home security lights, automatic doors and bathroom fixtures typically send out some type of energy, such as microwaves, ultrasonic waves or light beams and detect when the flow of energy is interrupted by something entering its path.

g) MIG Welding: In MIG welding the electrode is consumable. The filler metal is deposited by the arc which is completely surrounded by an inert gas. It is a process that utilizes a continuously fed solid electrode, shielding gas from an externally supplied source, and electrical power to melt the electrode and deposit this molten material in the weld joint. The equipment used automatically regulates the electrical characteristics of the arc. The only manual controls required of the welder for semi-automatic operation are travel speed, travel direction and torch positioning. Given proper equipment settings, the power supply will provide the necessary amperage to melt the electrode at the rate required to maintain the pre-selected arc length

h) Damped Vibration: When there is reduction in amplitude over every cycle of vibration, the motion is said to be damped vibration. This is due to the fact that a certain amount of energy possessed by the vibrating system is always dissipated in overcoming frictional resistance to the motion.

9. (a) What are the functions of an "Idle Wheel" in a wheel train?

5

Referring the following figure, the direction of two gears directly in contact will be opposite to each other.

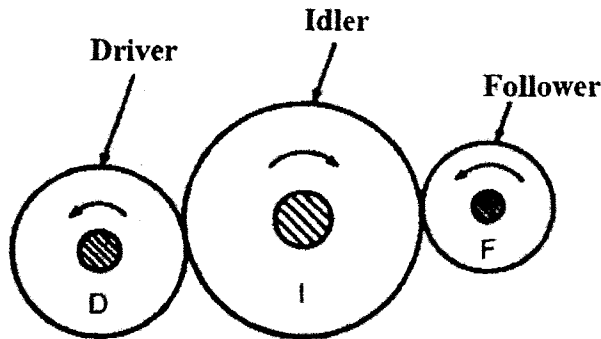


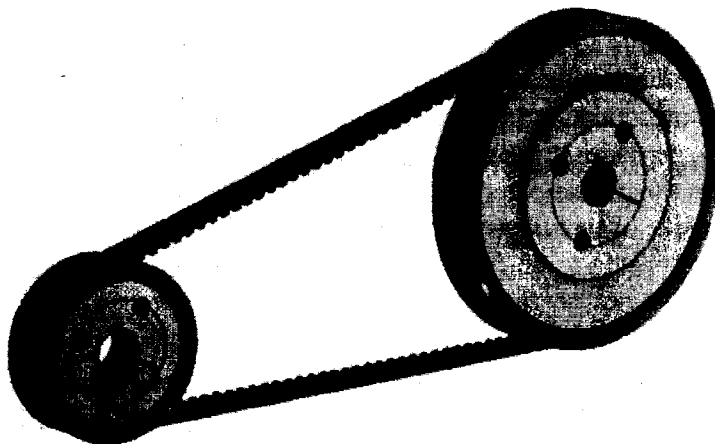
Fig.: Function of an Idle wheel

If instead of direct gearing the driver D with the follower F, a wheel I is introduced between the driver D and follower F, the driver D will drive the wheel I, and I will drive F, the effect of I being to make the wheel F turn in the same direction as D instead of in the opposite direction if it is connected directly with D. The wheel I is called the “Idle wheel” as it has no effect on the velocity ratio. The function of an idle wheel is, therefore, to change the direction of rotation of the train.

(b) Explain and illustrate “Positive Drive Power Transmission”.

5

Positive drive power Transmission: A positive drive is one that can provide constant velocity ratio during operation. Such drives are free from slip, creep, polygonal effect, leakage, etc. A gear drive is one positive drive. On the other hand, friction drives (belt and rope drive) are affected by slip and creep. Although chain drive is free from slip, it may not provide constant velocity ratio because of polygonal effect. Thus these are non-positive drive. V-belt and ribbed belt tend to eliminate slip; however, they may not necessarily provide constant velocity ratio, especially when workroom temperature varies substantially.



Synchronous belt on driving and driven sprockets

(c) What is “Diametral Pitch”?

3

Diametral pitch: It is the ratio of number of teeth to the pitch circle diameter.

(d) A pulley 40cm in diameter is driven at 600 rpm by a shaft revolving at a 300 rpm. Calculate the diameter of the shaft pulley if: 7

(1) There is slip of 4% and (2) there is no slip.

Solution: Given, Speed of the driver $N_1 = 300\text{rpm}$

Speed of the driven $N_2 = 600\text{rpm}$

Diameter of driven $D_2 = 40\text{cm} = 0.4\text{m}$

Diameter of driver $D_1 = ??$

1) For slip $s = 4\%$

We know;

$$\frac{N_2}{N_1} = \frac{D_1}{D_2} \left(1 - \frac{s}{100}\right)$$

$$\Rightarrow \frac{600}{300} = \frac{D_1}{0.4} \left(1 - \frac{4}{100}\right)$$

$$\therefore D_1 = \frac{5}{6} \text{m (Answer)}$$

2) For no slip;

We know;

$$\frac{N_2}{N_1} = \frac{D_1}{D_2}$$

$$\Rightarrow \frac{600}{300} = \frac{D_1}{0.4}$$

$$\therefore D_1 = 0.8\text{m (Answer)}$$

10. (a) What is work sampling? Explain the steps of work sampling. 6

Work sampling: Work sampling is the statistical technique used for determining the proportion of time spent by workers in various defined categories of activity (e.g. setting up a machine, assembling two parts, idle...etc.). It is as important as all other statistical techniques because it permits quick analysis, recognition, and enhancement of job responsibilities, tasks, performance competencies, and organizational work flows. Other names used for it are 'activity sampling', 'occurrence sampling', and 'ratio delay study'.

In a work sampling study, a large number of observations are made of the workers over an extended period of time. For statistical accuracy, the observations must be taken at random times during the period of study, and the period must be representative of the types of activities performed by the subjects.

One important usage of the work sampling technique is the determination of the standard time for a manual manufacturing task. Similar techniques for calculating the standard time are time study, standard data, and predetermined motion time systems.

There are several recommended steps when starting to prepare a work sampling study:

- Define the manufacturing tasks for which the standard time is to be determined.
- Define the task elements. These are the defined broken-down steps of the task that will be observed during the study. Since a worker is going to be observed, additional categories will likely be included as well, such as "idle", "waiting for work", and "absent".

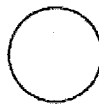
- Design the study. This includes designing the forms that will be used to record the observations, determining how many observations will be required, deciding on the number of days or shifts to be included in the study, scheduling the observations, and finally determining the number of observers needed.
- Identify the observers who will do the sampling.
- Start the study. All those who are affected by the study should be informed about it.
- Make random visits to the plant and collect the observations.
- After completing the study, analyze and present the results. This is done by preparing a report that summarizes and analyzes all data and making recommendations when required.

(b) Draw the symbols, their name and description for process chart-product analysis and process chart-man analysis. 7

Process chart-product analysis:

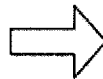
- **Operation**

Physical change to Products
Value Added



- **Transportation**

Object is moved
Non Value Added



- **Inspection**

Inspect/Test
Non Value Added



- **Delay**

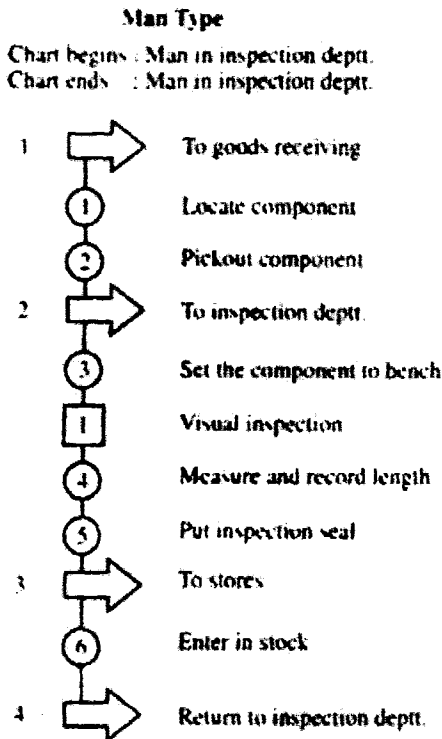
Unplanned stop of work (Progress)
Non Value Added



- **Storage**

Held by design plan
Non Value Added



Process chart-Man analysis:

(c) Why “Control Chart” works? What type of conclusion can 7
generally be drawn from “Control Charts”?

Control charts are a very useful statistical quality control tool. These charts are used to evaluate whether a process operating is either under control or out of control. The control chart may be used for variables (such as weight, length, diameter, etc.) and attributes (defects and defectives).

Data in a control chart are plotted in time order. A control chart always has a central line for the average, an upper line for the upper control limit, and a lower line for the lower control limit. These lines are determined from historical data. By comparing current data to these lines, we can draw conclusions about whether the process variation is consistent (in control) or is unpredictable (out of control, affected by special causes of variation).

**11.(a) The water behind “Kaptai Dam” is 30m higher than that of the 10
discharge river. At what rate the water must pass through the
hydraulic turbines of this dam to produce 250 MW of power if the
turbines are 100% efficient.**

Solution:

We know, $\eta = \frac{\text{Turbine output power}}{\text{Hydraulic input power}}$

$$\Rightarrow 100\% = \frac{250 \times 10^6}{\gamma \times Q \times H}$$

$$\therefore Q = \frac{250 \times 10^6}{\gamma \times H} = \frac{250 \times 10^6}{9.81 \times 1000 \times 30} = 849.47 \text{ m}^3/\text{s} = 849473.32 \text{ L/s (Answer)}$$

(b) Air enters a nozzle steadily at 2.21 kg/m³ and 30 m/s and leaves at 0.762 kg/m³ and 180 m/s. If the inlet area of the nozzle is 80 cm², determine

10

(i) The mass flow rate through the nozzle and

(ii) The exit area of the nozzle

Solution:

Given, $v_i = 30 \text{ m/s}$; $A_i = 80 \text{ cm}^2 = 80 \times 10^{-4} \text{ m}^2$; $v_i = 2.21 \text{ kg/m}^3$

And $v_e = 180 \text{ m/s}$; $v_e = 0.762 \text{ kg/m}^3$

To determine \dot{m}_s and A_e

$$\text{We know, } \dot{m}_s = \frac{A_i v_i}{v_i} = \frac{80 \times 10^{-4} \times 30}{2.21} = 0.1086 \text{ kg/s (Answer)}$$

Now, $A_i v_i = A_e v_e$

$$\Rightarrow A_e = \frac{A_i v_i}{v_e} = \frac{80 \times 10^{-4} \times 30}{180} = 13.33 \text{ cm}^2 \text{ (Answer)}$$

12.(a) What is an organization?

2

According to Oliver Sheldon, "Organization is the process so combining the work which individuals or groups have to perform with the facilities necessary for its execution, that the duties so performed provide the best channels for the efficient, systematic, positive and coordinated application of the available effort". Organization helps in efficient utilization of resources by dividing the duties of various persons.

According to Louis Allen, "Organization is the process of identifying and grouping work to be performed, defining and delegating responsibility and authority and establishing relationships for the purpose of enabling people to work most effectively together in accomplishing objectives." In the words of Allen, organization is an instrument for achieving organizational goals. The work of each and every person is defined and authority and responsibility is fixed for accomplishing the same.

(b) What are the types of organization?

3

On the basis of administrative procedures, there are three basic types of organizations:

- line organization,
- line and staff organization,
- and functional organization.

There are some other classes of organizations such as project organization, matrix organization, etc.

(c) Discuss the advantages and disadvantages of "line organization"?

10

Advantages of Line Organization:

1. Simplest: It is the most simple and oldest method of administration.
2. Unity of Command: In these organizations, superior-subordinate relationship is maintained and scalar chain of command flows from top to bottom.
3. Strong discipline: The control is unified and concentrates on one person and therefore, he can independently make decisions of his own. Unified control ensures better discipline.

4. **Fixed responsibility:** In this type of organization, every line executive has got fixed authority, power and fixed responsibility attached to every authority.
5. **Flexibility:** There is a co-ordination between the top most authority and bottom line authority. Since the authority relationships are clear, line officials are independent and can flexibly take the decision. This flexibility gives satisfaction of line executives.
6. **Quick decision:** Due to the factors of fixed responsibility and unity of command, the officials can take prompt decision.

Disadvantages:

1. **Over-reliance:** The line executive's decisions are implemented to the bottom. This results in over-relying on the line officials.
2. **Lack of specialization:** A line organization flows in a scalar chain from top to bottom and there is no scope for specialized functions. For example, expert advices whatever decisions are taken by line managers are implemented in the same way.
3. **Inadequate communication:** The policies and strategies which are framed by the top authority are carried out in the same way. This leaves no scope for communication from the other end. The complaints and suggestions of lower authority are not communicated back to the top authority. So there is one way communication.
4. **Lack of co-ordination:** Whatever decisions are taken by the line officials, in certain situations wrong decisions, are carried down and implemented in the same way. Therefore, the degree of effective co-ordination is less.
5. **Authority leadership:** The line officials have tendency to misuse their authority positions. This leads to autocratic leadership and monopoly in the concern.

(d) Describe the function of a "Manager" in a typical business organization.

5

Solutions:

Management is the process of guiding the development, maintenance, and allocation of resources to attain organizational goals. Managers are the people in the organization responsible for developing and carrying out this management process. The four primary functions of managers are planning, organizing, leading, and controlling. By using the four functions, managers work to increase the efficiency and effectiveness of their employees, processes, projects, and organizations as a whole.

Planning

One main role of a manager is creating a plan to meet company goals and objectives. This involves allocating employee resources and delegating responsibilities, as well as setting realistic timelines and standards for completion. Planning requires those in management roles to continuously check on team progress in order to make small adjustments when necessary, while still maintaining a clear picture of a company's larger aims and goals.

Much of one's planning function consists of working independently to determine what responsibilities must be given to which employees, setting priority levels for certain tasks, and creating timelines. However, communication also plays an important role. For example, managers deal with planning when they meet with company leadership to discuss short and long-term goals, and when they communicate the specifics of a new project to their team or check-in periodically to ensure individual objectives are being met

on time.

Organizing

Along with planning, a manager's organizational skills can help to ensure a company or departmental unit runs smoothly. From establishing internal processes and structures to knowing which employees or teams are best suited for specific tasks, keeping everyone and everything organized throughout daily operations are important functions of management.

Organization isn't just about delegating tasks efficiently and making sure employees have what they need to accomplish their tasks, however. Managers also need to be able to reorganize in response to new challenges. This could come into practice in the form of slightly adjusting the timeline for a project or re-allocating tasks from one team to another. Or, it could mean significantly altering a team's internal structure and roles in response to company growth.

Leading

Managers should be comfortable and confident commanding their team members' daily tasks as well as during periods of significant change or challenge. This involves projecting a strong sense of direction and leadership when setting goals and communicating new processes, products and services, or internal policy.

Leadership can manifest itself in a number of ways, including recognizing when employees need an extra boost of reinforcement and praise to handling conflicts between team members fairly and decisively. Often, managers may function as leaders even during small personal interactions by modeling supportive, encouraging, and motivational qualities.

Controlling

To ensure all of the above functions are working toward the success of a company, managers should consistently monitor employee performance, quality of work, and the efficiency and reliability of completed projects. Control (and quality control) in management is about making sure the ultimate goals of the business are being adequately met, as well as making any necessary changes when they aren't.

13.(a) Discuss the four distinct phases of the combustion process in an SI Engine. 5

We can divide the combustion process into four distinct phases:

(1) spark ignition (2) early flame development (3) flame propagation (4) flame termination

The combustion process of SI engines can be divided into three broad regions: (1) ignition lag (2) flame propagation, and (3) after burning

1) Ignition lag or preparation phase (AB):

- growth and development of a semi propagating nucleus of flame.
- chemical process depending upon the nature of the fuel, upon both temperature and pressure, the proportion of the exhaust gas, and also upon the temperature coefficient of the fuel, that is, the relationship of oxidation or burning.
- point A shows the passage of spark and point B is the first rise of pressure.

- ignition lag is generally expressed in terms of crank angle.
- Ignition lag is very small and lies between 0.00015 to 0.0002 seconds.
- Ignition lag of 0.002 seconds corresponds to 35 deg crank rotation when the engine is running at 3000 RPM.
- Angle of advance increase with the speed.

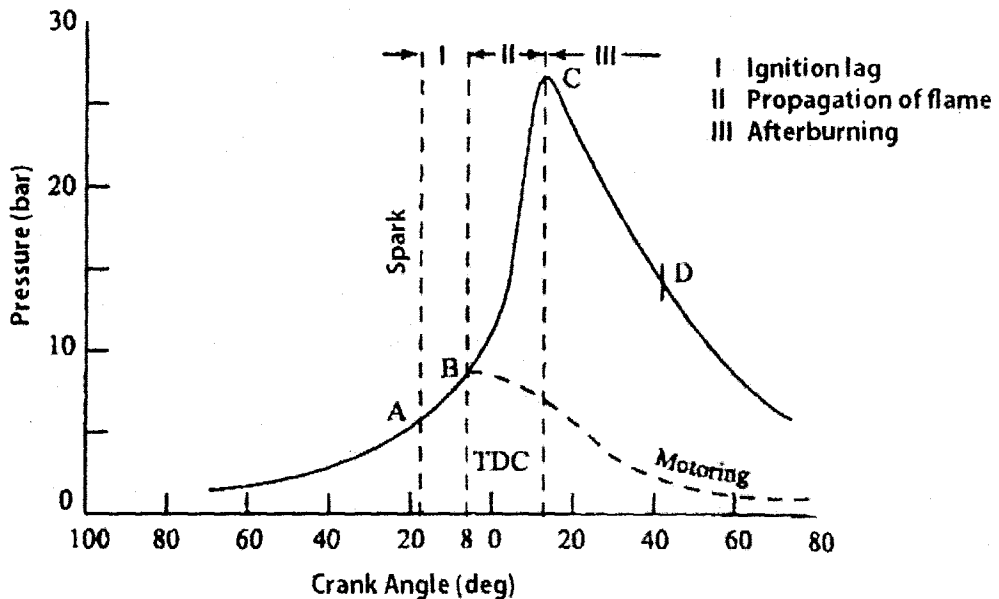


Figure: Stages of combustion in SI engine

2) propagation of flame (BC):

- Period from the point B where the line of combustion departs from the compression line to point C, the maximum rise of pressure in P- θ diagram.
- Flame propagates at the constant velocity.
- Heat transfer to the cylinder wall is low.
- Rate of heat release depends upon the turbulence intensity and reaction rate.

3) After burning (CD):

- After point C, the heat release is due to the fuel injection in reduced flame front after the starts of expansion stroke.
- No pressure rise during this period.

(b) Explain the phenomenon of diesel knock. Compare it with the phenomenon of detonation in SI Engine. 5

Solutions:

Phenomenon of diesel knock: Satisfactory combustion of diesel fuel requires extremely fine atomization of the fuel and precise regulation of the start and finish timing of the injection period. The normal pressure cycle of diesel combustion can be adversely affected by a range of influences, three of which are particularly notable: 1. Ignition delay

2. Incomplete combustion 3. Leaking injectors

The injected liquid fuel droplets must reach distillation temperature and vaporize before ignition occurs. This requires a time delay between the points of injection and ignition. If the commencement of ignition is further delayed for any reason, then there is an increase in the volume of uncombusted fuel in the combustion chamber and when ignition does occur, the result is a rough running engine (known as diesel knock). If this condition continues, engine component overload and failure are likely. This could include piston crown and ring land fracture.

Comparison with the phenomenon of detonation in SI Engine:

Spark-ignition knock is caused by the spontaneous ignition of gas ahead of the propagating flame front (the end gas) within the combustion chamber. This spontaneous ignition results in a rapid release of chemical energy and an accompanying rapid rise in cylinder pressure. Unlike spark-ignition knock, diesel knock occurs when injected fuel auto-ignites and combusts in the premixed stage of combustion. Whilst this process is a normal part of diesel engine operation, various circumstances can lead to excess quantities of fuel combusting in a premixed fashion. This situation often develops if the parameters governing combustion lead to abnormally long ignition delay periods. As a consequence, excessive diesel knock can often be a symptom of underlying faults such as poor or contaminated fuels, injection system problems or unsuitable rates of alternative fuel substitution.

(c) Show the energy flow in an IC Engine.

3

Answer: Same as 4(b), Second Paper, 34th BCS,

(d) A four cylinder two stroke cycle petrol engine develops 23.5kW 7
break power at 2500 rpm. The mean effective pressure at each piston is 8.5 bar and the mechanical efficiency is 85%. Calculate the diameter and stroke of each cylinder, assuming the length of the stroke equal to 1.5 times the diameter of the cylinder.

Solution: Given,

No of cylinder, $k = 4$,

Speed, $N = 2500$ rpm

Number of working strokes per minute, $n = N$ (for two stroke cylinder engine) = 2500

Brake Power, $BP = 23.5$ kW

Mechanical Efficiency, $\eta_{\text{mech}} = 85\%$

Mean effective pressure, $P_m = 8.5$ bar = 850 kPa

Let, diameter = d ,

Stroke length = $1.5 \times d$

Mechanical Efficiency = 0.85

$$\begin{aligned} \text{We know, mechanical efficiency} &= \frac{\text{Brake power}}{\text{Indicated power}} \\ \Rightarrow \text{Indicated power} &= \frac{23.5 \text{ kW}}{0.85} \\ &= 27.65 \text{ kW} \end{aligned}$$

$$\text{Indicated Power} = \frac{P_m \times L \times A \times n \times k}{60}$$

$$\Rightarrow 27.56 = \frac{P_m \times 1.5 \times d \times \left(\frac{\pi}{4}\right) \times d^2 \times n \times k}{60}$$

$$\Rightarrow 27.56 = \frac{850 \times 1.5 \times d \times \left(\frac{\pi}{4}\right) \times d^2 \times 2500 \times 4}{60}$$

$$\Rightarrow d = 0.55\text{m} = 55 \text{ mm}$$

Diameter, $d = 55 \text{ mm}$

Stroke length, $l = 1.5 \times 55 = 82.38 \text{ mm}$

14.(a) Name the principal materials which are used for cutting tools.

3

Principal material used for cutting tools:

1. Carbon tool steels
2. High speed steel
3. Cast cobalt alloys
4. Cemented Carbides
5. Ceramics tool
6. Diamond tool
7. Cubic boron nitride (CBN)

(b) What are the differences between “single point cutting tool” and “multi point cutting tool”.

2

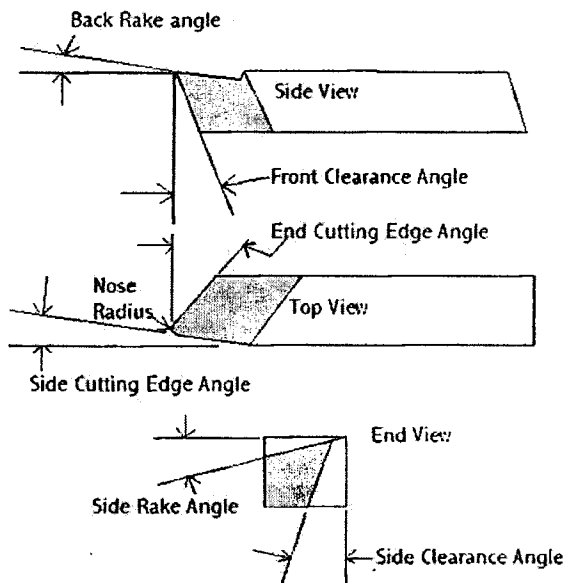
Single point cutting tool	Multi point cutting tool
Singles point cutting tool contain only one main cutting edge in the cutter body.	Multi point cutting tool contain more than one cutting edges in the cutter body.
While machining with single point cutting tool, only one main cutting edge continuously remains in contact with workpiece.	While machining with multi point cutting tool, more than one cutting edges simultaneously engage in material removal action in a pass.
Chip load per tooth is usually high.	Due to presence of multiple cutting edges, effective chip load per tooth, reduces.
Design and fabrication of single point cutting tools are easier.	Design and fabrication of multi point cutting tools are quite difficult.
Single point cutting is a Low-cost tool.	Multi-point cutting is a High-cost tool.
Cutting tool temperature is high.	Compare to the single-point cutting tool the cutting temperature is low.
Tool life of single point is a shorter comparatively multi-point cutting tool.	Its tool life is more.
Low material removal rate.	Good or More material removal rate compared to a single-point cutting tool.
The tool wear rate is high.	The tool wear rate is low.
In terms of accuracy, this one provides a good surface finish.	But a Multi-point cutting tool provides greater surface finish.

(c) Sketch a single point cutting tool bit and indicate different tool

5

angles.

Tool Bit Geometry



Lathe tool (single point cutting tool)

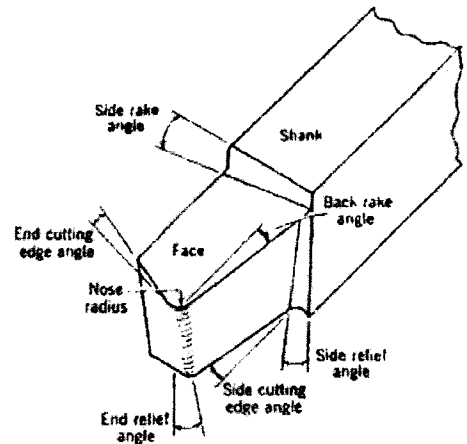


Fig: Single point cutting tool bit with different angles

(d) What is welding? What are the methods of welding?

3+3=6

Welding: The welding is a process of joining two similar or dissimilar metals by fusion, with or without the application of pressure and with or without the use of filler metal.

Methods of welding: The welding is broadly into the following two groups:

1. Forge or pressure welding
2. Fusion or non-pressure welding

Electric resistance welding: It is a type of pressure welding. The various types of electric resistance welding are as follows:

- i) Spot welding
- ii) Roll spot and seam welding
- iii) Projection welding
- iv) Butt welding

Arc welding: It is a fusion welding process. Following are the two types of arc welding depending upon the type of electrode:

- i) Un-shielded arc welding
- ii) Shielded arc welding

In other words;

Metallic inert-gas (MIG) arc welding
Tungsten inert-gas (TIG) arc welding

(e) Name different tools, appliances and materials which are required in electric arc welding. 4

Tools:

- i) Safety glasses
- ii) Auto-darkening welding helmet
- iii) Chipping hammer
- iv) Wire brush
- v) Gauntlet cuff gloves
- vi) TIG welding gloves
- vii) Proband welding jacket
- viii) Ear protection
- ix) Soapstone
- x) MIG pliers

Appliances:

- i) Welding Machine
- ii) Electrode holders
- iii) Cables
- iv) Cable connectors and lugs
- v) Power wire wheel

Materials:

- i) Steel and stainless steel
- ii) Aluminum
- iii) Cast iron
- iv) Titanium
- v) copper and brass
- vi) Magnesium alloy

38th BCS

MECHANICAL ENGINEERING

Subject Code: 901

Time –4 hours

Full Marks–200

[N.B.— Answer any five questions from each part. Figures in the right margin indicate full marks.]

Part I

Marks: 20×5=100

Marks

1. (a) What is an Ideal gas? Under what conditions does a real gas behave as an ideal gas? 6

Ideal gas: An ideal gas may be defined as a state of a substance, whose evaporation from its liquid state is complete and strictly obeys all the gas laws under all conditions of temperature and pressure.

The assumptions of ideal gas are-

1. The collisions occurring between molecules are elastic and their motion is frictionless.
2. The total volume of the individual molecules is magnitudes smaller than the volume that the gas occupies.
3. There are no intermolecular forces acting between the molecules or their surroundings.
4. The molecules are constantly in motion, and the distance between two molecules is significantly larger than the size of an individual molecule.

A real gas has molecules that have a non-zero volume and have intermolecular forces that are also not zero. An ideal gas has molecules of zero size and zero intermolecular forces. If the real gas is low pressure and reasonably high temperature then it will behave like an ideal gas in that measuring equipment will not be accurate enough to measure a difference. As the pressure gets higher or the temperature gets low enough, the differences between an ideal gas and a real gas become measurable. So, at low pressure and reasonably high temperature the real gas behave like an ideal gas.

(b) Name the variables which control the physical properties of a perfect (or an ideal) gas? 6

Answer: Laws of perfect gases are

Boyle's law: The absolute pressure of a given mass of a perfect gas varies inversely as its volume, when the temperature remains constant.

Mathematically, $p \propto \frac{1}{v}$ or, $p v = \text{constant}$

Charles' law: The volume of a given mass of a perfect gas varies directly as its absolute

temperature, when the absolute pressure remains constant.

Mathematically, $v \propto T$ or, $\frac{v}{T} = \text{Constant}$

Gay-Lussac law: The absolute pressure of a given mass of a perfect gas varies directly as its absolute temperature, when the volume remains constant.

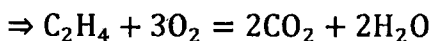
Mathematically, $p \propto T$ or, $\frac{p}{T} = \text{Constant}$

From the laws discussed above it can be said that physical properties of a perfect gas is controlled by following three variables

1. Pressure exerted by the gas
2. Volume occupied by the gas
3. Temperature of the gas

(c) 1.0 kg of ethylene requires 2.0 kg of Oxygen and produces carbon dioxide (22/7 kg) and water. Calculate the amount of water (in kg).

Solution: Chemical reaction for the given case:



$$\Rightarrow 28 + 96 = 88 + 36$$

$$\Rightarrow 1\text{kg} + \frac{24}{7}\text{kg} = \frac{22}{7}\text{kg} + \frac{9}{7}\text{kg}$$

$\therefore \frac{9}{7}\text{kg}$ water will be produced (Answer)

2. (a) Write down the steady flow energy equation with assumptions and simplify the equation for compressor.

Answer: Steady flow energy equation with assumptions:

Assumptions:

- (i) The mass flow through the system remains constant.
- (ii) Fluid is uniform in composition.
- (iii) The only interaction between the system and surroundings are work and heat.
- (iv) The state of fluid at any point remains constant with time.
- (v) In the analysis only potential, kinetic and flow energies are considered.

Steady flow energy equation:

$$q - w = (h_2 - h_1) + \left(\frac{v_2^2}{2} - \frac{v_1^2}{2} \right) + (z_2 - z_1)g$$

$$q - w = \Delta h + \Delta ke + \Delta pe \text{ (J/kg)}$$

where; q = Heat transfer per unit mass in (J/kg)

w = Work transfer per unit mass in (J/kg)

$\Delta h = \Delta u + \Delta(pv)$ = Specific enthalpy change.

Steady flow energy equation for compressor: Consider the reciprocating compressor work input per unit mass $w = -ve$

Heat rejection (if any) $q = -ve$

Change in potential energy $\Delta pe = 0$

Change in kinetic energy $\Delta ke = 0$

So the steady flow energy equation for reciprocating compressor becomes;

$$Q - w = (h_2 - h_1) \text{ (J/kg)}$$

Now consider the centrifugal compressor;

Change in potential energy $\Delta p_e = 0$

Work input per unit mass $w = -ve$

Heat rejection (if any) $q = -ve$

So the steady flow energy equation for centrifugal compressor becomes;

$$q - w = \left[(h_2 - h_1) + \left(\frac{v_2^2}{2} - \frac{v_1^2}{2} \right) \right] \text{ (J/kg)}$$

(b) Why safety valve is used in steam boiler and what are the different types of safety valve used in different steam boiler? 6

Answer: Reasons for safety valve in steam boiler: A safety valve is usually referred to as the last line of safety defense. Without safety valve, the boiler can exceed its maximum allowable working pressure (MAWP) and not only damage equipment, but also injure or kill plant operators that are closed by. Safety valve prevent explosions due to excessive internal pressure of steam. A steam boiler is, usually provided with two safety valves. The function of a safety valve is to blow off the steam when the pressure of steam inside the boiler exceeds the working pressure. So for proper and safe functioning of steam boiler safety valve is very important.

Different types of safety valve used in different steam boiler:

1. Lever safety valve: It is used on the steam boilers. It serves the purpose of maintaining constant safe pressure inside the steam boiler. If the pressure inside the boiler exceeds the designed limit, the valve lifts from its seat and blow off the steam pressure automatically.

2. Dead weight safety valve: It is used for stationary boilers. When the pressure of steam exceeds the normal pressure, the valve as well as the case are lifted up from its seat. This enables the steam to escape through the discharge pipe, which carries the steam outside the boiler house.

3. High steam low water safety valve: These valves are placed on the top of Cornish and Lancashire boiler. It is a combination of two valves, one of which is the lever safety valve which blow off steam when the working pressure of steams exceeds. The second valve operates by blowing off the steam when the water level becomes too small.

4. Spring loaded safety valve: It is mainly used for locomotives and marine boilers. It is loaded with spring instead of weights.

(c) In a steam boiler, feed water supplied per hour is 215 kg while coal fired per hour is 23 kg. The net enthalpy rise per kg of water is 145 KJ. If the calorific value of coal is 2150 KJ/Kg, what is the efficiency of the boiler? 8

Solution: Given, $m_s = 215 \text{ kg/hr}$, $m_f = 23 \text{ kg/hr}$, $h - h_{f1} = 145 \text{ KJ/kg}$

$C = 2150 \text{ KJ/kg}$

Boiler efficiency $\eta = ?$

We know; $\eta = \frac{m_s (h - h_{f1})}{m_f C} = \frac{215 \times 145}{23 \times 2150} = 0.63 = 63\% \text{ (Answer)}$

3. (a) How is thermal conductivity of a material defined? Mention the effects of various parameters on the thermal conductivity of solids. 6

Answer: Thermal conductivity: Thermal conductivity of a material is numerically equal to

the quantity of heat which flows in one second through a slab of the material of unit area and unit thickness when its faces differ in temperature by 1K.

Effects of various parameters on thermal conductivity:

1. **Material:** The kind of material being used in thermal conductivity can affect the rate of energy flowing between the two regions. The greater the conductivity of the material, the faster the energy flows. According to the Physics Hypertextbook, the material with the greatest conductivity is helium II. Other materials with high conductivity are diamonds, graphite, silver, copper and gold.
2. **Thickness:** The thickness of the material the energy must flow through can affect the rate at which it flows. The shorter the thickness, the faster it will flow. The thermal conductivity may continue to increase even when the thickness is increased.
3. **Temperature difference:** Thermal conductivity varies depending on temperature. Depending on the material of the conductor, as the temperature rises the thermal conductivity of the material often rises as well, increasing the flow of energy.
4. **Cross – section type:** The cross-section type, such as round, C- and hollow-shaped, can affect the thermal conductivity, according to the Journal of Materials Science. The article reports that the thermal diffusivity factor of C- and hollow-shaped carbon fiber-reinforced composites showed about two times higher values than those of round-type ones.

(b) What are Fourier and Biot numbers? What are the physical significance of these numbers? 5

Answer: Fourier number: The ratio of the rate of heat conducted to the rate of heat stored at that time.

Biot number: The ratio of the convection at the surface of the body to the conduction within the body.

Significance of Fourier number:

Fourier number is a measure of heat conducted through a body relative to heat stored. Thus, a large value of the Fourier number indicates faster propagation of heat through a body.

Significance of Biot number:

A small biot number represents small resistance to heat conduction and thus small temperature gradients within the body.

If the value of biot number (Bi) ≤ 0.1 then the lumped system analysis is applicable.

(c) A gas filled tube has a 2mm inside diameter and 25cm length. The gas is heated by an electrical wire of diameter 0.05mm located the axis of the tube. The current and the voltage drop across the heating element are 0.5amps and 4 volts respectively. If the measured wire and inside tube wall temperatures are 175°C & 150°C. Find the thermal conductivity of the gas filling the tube. 9

Solution: Given, $r_2 = (2 \div 2) \text{ mm} = 1\text{mm}$, $r_1 = (0.05 \div 2)\text{mm} = 0.025\text{mm}$

$T_1 = 175^\circ\text{C} = 448\text{K}$, $T_2 = 150^\circ\text{C} = 423\text{K}$, $L = 25\text{cm} = 0.25\text{m}$,

$V = 4 \text{ volts}$, $I = 0.5 \text{ amp}$

We know that heat transfer rate $Q = P = VI \text{ watt}$

$$Q = 4 \times 0.5 = 2 \text{ watt}$$

We also know radial heat conduction through cylinder is;

$$Q = \frac{2\pi kL(T_1 - T_2)}{\ln(r_2/r_1)}$$

$$\Rightarrow 2 = \frac{2\pi k \times 0.25 (448 - 423)}{\ln(1/0.025)}$$

$$\therefore k = 0.1878 \text{ W/m K (Answer)}$$

4. (a) State the laws with their equations which govern the radiation heat transfer? 6
What is a radiation shield?

Answer: Kirchoffs law: Kirchoffs law states that the absorptivity (a) of a substance for radiation of a specific wavelength is equal to its emissivity for the same wavelength.

$$a(\lambda) = e(\lambda)$$

Stefan-Boltzman's Law: This law states that the intensity of radiation emitted by a radiating body is proportional to the fourth power of the absolute temperature of that body.

$$E_b = \epsilon \sigma T^4$$

Where, E_b = Radiation flux

ϵ = emissivity

σ = Stefan – Boltzman's constant

T = Body temperature

Planck's law: It describes the spectral density of electromagnetic radiation emitted by a black body in thermal equilibrium at a given temperature T , when there is no net flow of matter or energy between the body and its environment.

$$E = h\nu ;$$

Where, h = Planks constant; ν = frequency

Radiation shield: Radiation shield is a resistance in the heat-flow path so that the overall heat transfer is retarded. These shields do not deliver or remove any heat from the overall system.

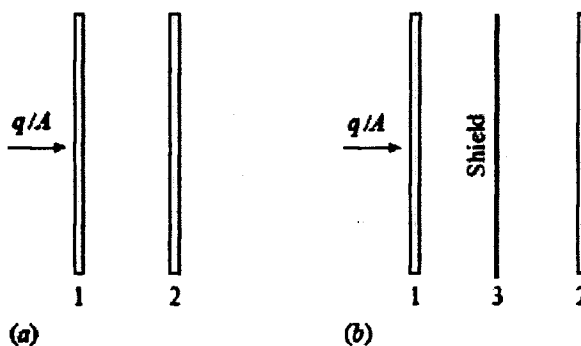


Figure: Radiation between two parallel planes with (b) and without (a) radiation shield.
(b) What is a black body? How does it differ from a gray body? 5

Answer:

Black Body: A black body or blackbody is an idealized physical body that absorbs all incident electromagnetic radiation, regardless of frequency or angle of incidence. The name "black body" is given because it absorbs radiation in all frequencies, not because

it only absorbs: a black body can emit black body radiation.

Black body	Gray Body
Blackbody is an idealized physical body that absorbs all incident electromagnetic radiation	Gray body does not absorb all incident electromagnetic radiation.
Perfect absorber and perfect emitter	It is not perfect emitter and perfect emitter.
Can absorb all incident electromagnetic wave.	Can't absorb all electromagnetic wave.
Perfect emitter	It considered as opaque object
Non reflective body	Reflection occurs.

(c) Two large parallel plates with $\epsilon=0.5$ each are maintained at different temperatures and are exchanging heat only by radiation. Two equally large radiation shields with surface emissivity 0.5 are introduced in parallel to the plates. Find the percentage reduction in net radioactive heat transfer. Consider all resistances per unit surface area. 9

Solution: Given, $\epsilon_1 = \epsilon_2 = \epsilon = 0.5$; $N = 2$

We know, $Q_{12, \text{no shield}} = \frac{A\sigma(T_1^4 - T_2^4)}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1}$

And $Q_{12, N \text{ shield}} = \left(\frac{1}{N+1}\right) \frac{A\sigma(T_1^4 - T_2^4)}{\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1}$

Here, $N=2$; $\therefore \frac{1}{N+1} = \frac{1}{2+1} = \frac{1}{3} = 0.33$;

Heat transfer reduces to one-third of the no shield radiation heat transfer.

So, $(1-0.33)=0.67$ or 67% reduction in radiation heat transfer. (Answer)

5. Write short notes with necessary sketch (any four):

5×4=20

(a) Vapor compression refrigeration system

(b) Submersible pump

(c) Heat pump

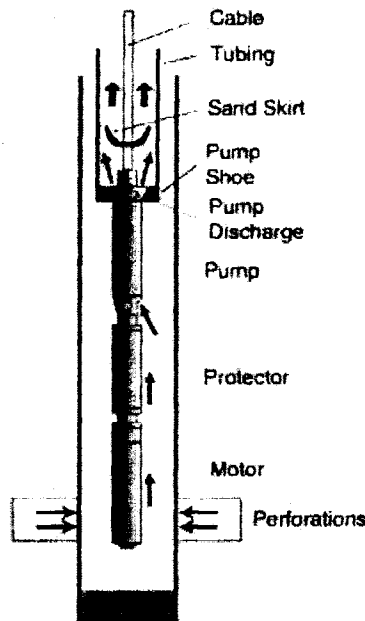
(d) Induced draft

(e) Mach number

Answer:

(a) **Vapor compression refrigeration system:** see at "Fundamental of Mechanical Engineering vol.1, chap.6."

(b) **Submersible pump:** A submersible pump is a centrifugal pump, which is attached to an electric motor and operates while submerged in water. The sealed electric motor spins a series of impellers.



Start-up: Before starting the pump, close the restrictor valve almost completely. Start the pump and gradually open the restrictor valve until the pump is either (a) pumping at full well yield, (b) pumping at rated capacity, or (c) begins pumping sandy water. In the last situation, submersible pumps will wear out very quickly if they pump water containing sand. In some situations, restricting the pump using the restrictor valve will be all that is necessary to prevent sand from being lifted up the well casing and into the pump. The pump should never be shut off while pumping sandy water. The pump should be restricted until the water comes clear.

Maintenance: No regular maintenance is required on submersible pumps. When a three-wire submersible pump fails, check the pump control box with electrical meters before removing the pump from the well.

Advantages: Submersible pumps are efficient, high in capacity, require very little maintenance and are generally very economical for wells that are 80 feet or more in depth.

Limitations: The tolerances between the impellers and diffusers are relatively small; therefore, submersible pumps are unsuitable for pumping water that contains sand or other abrasives. Submersible pumps are water cooled and water lubricated. They should not be installed in wells that will pump dry, unless they are protected by a liquid level control. Submersible pumps are not suitable for pumping water containing a high concentration of dissolved gases because the pump may become gas locked.

(c) Heat pump: A heat pump is a device, operating in a cycle, that maintains a space at a higher temperature than the surroundings. The heat pump supplies heat continuously to the controlled space and thus maintained the higher temperature to the surroundings.

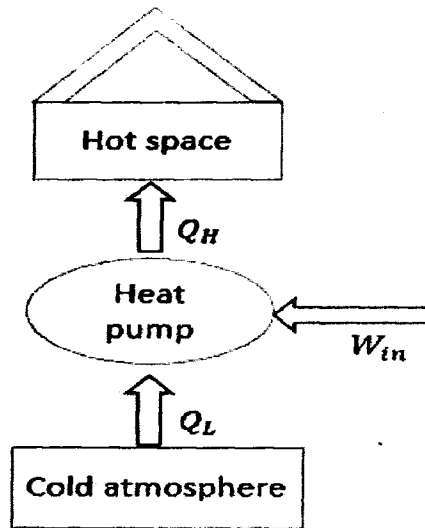


Figure: Schematic of a Heat pump

$$(\text{COP})_{\text{HP}} = \frac{\text{Heat supplied}}{\text{Work input}} = \frac{Q_H}{W_{\text{in}}}$$

$$\text{But, } Q_H = Q_L + W_{\text{in}}$$

$$\text{Now, } (\text{COP})_{\text{HP}} = \frac{Q_L + W_{\text{in}}}{W_{\text{in}}} = 1 + \frac{Q_L}{W_{\text{in}}} = 1 + (\text{COP})_{\text{R}}$$

(d) Induced draft: When natural draft is not sufficient, mechanical draft should be generated. Induced draft is a type of mechanical or artificial draft.

- Fan is placed after the grate
- Pressure inside the furnace is below the atmospheric pressure.
- It sucks hot gases from the combustion chamber and forces them into the chimney
- For handling hot air, more power required

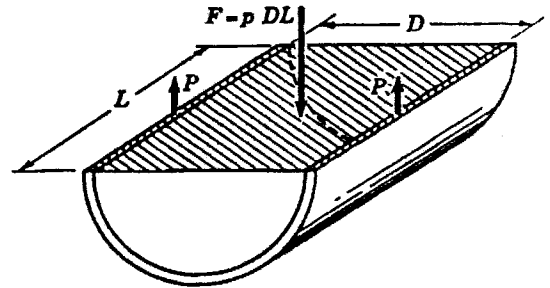
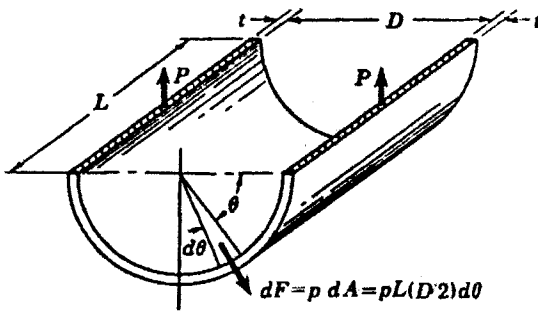
Mach number: “Fundamentals of Mechanical Engineering vol.1, chapter-4”

6. (a) Draw shear force and bending moment diagram of cantilever beam with gradually varying load. 5

Answer: “Fundamentals of Mechanical Engineering vol.1, chapter-7”

(b) Describe the following (any two): (i) Hoop stress (ii) Modulus of resilience 5×2=10
(iii) Mohr circle diagram.

Answer: (i) Hoop stress: The stress acting along the circumference of the cylinder is called circumferential stress or hoop stress.



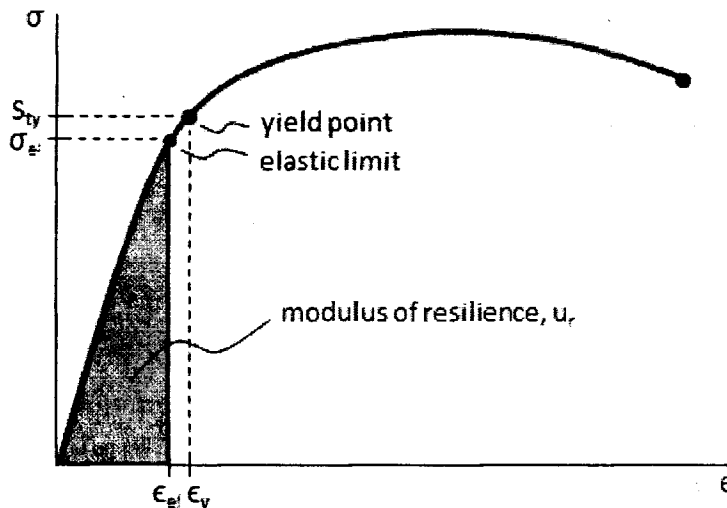
$$dF = p dA = pL \frac{D}{2} d\theta$$

$$\therefore F = \int_0^\pi (pL \frac{D}{2} d\theta) \sin \theta = pL \frac{D}{2} [-\cos \theta]$$

So, $F = pDL$

$$\text{Now, } \sigma_t = \frac{pDL}{2tL} = \frac{pD}{2t} = \text{hoop stress}$$

(ii) Modulus of resilience: Modulus of resilience is the maximum amount of energy per unit volume that a material can absorb and still return to its original position.



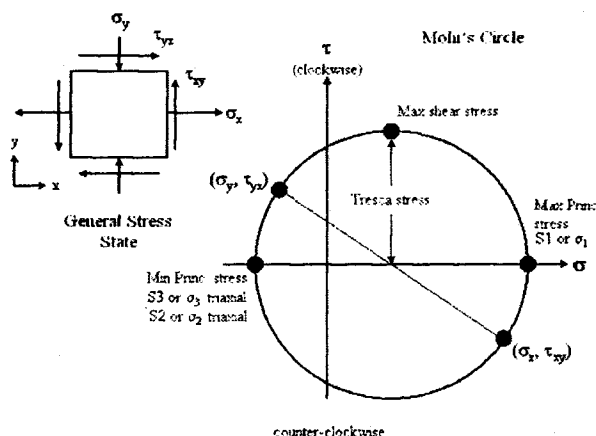
$$\text{Modulus of resilience} = U_r \text{ or } \mu = \frac{\sigma_y^2}{2E}$$

Where,

1. U_r or μ is the modulus of resilience.
2. σ_y is the yield strain.
3. And E is young's modulus.

(iii) Mohr circle diagram: The transformation equations for plane stress can be represented in graphical form by a plot known as Mohr's Circle. This graphical representation is extremely useful because it enables you to visualize the relationships between the normal and shear stresses acting on various inclined planes at a point in a stressed body. Using Mohr's

Circle you can also calculate principal stresses, maximum shear stresses and stresses on inclined planes.



$$\sigma_{avg} = \frac{\sigma_x + \sigma_y}{2}; R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

Substitute σ_{avg} and R to get

$$(\sigma_{x1} - \sigma_{avg})^2 + \tau_{x1y1}^2 = R^2$$

\therefore Centre of the Mohr circle is $(\sigma_{avg}, 0)$ and radius R .

(c) Define specific speed and unit speed of a turbine.

5

Answer:

Specific speed: It is defined as the speed of a turbine which is identical in shape, geometrical dimensions, blade angles, gate operating etc. with the actual turbine but of such a size that it will develop unit power when working under unit head. The specific speed used in comparing different types of turbine as every type of turbine has different specific speed.

$$N_s = \frac{N\sqrt{P}}{H^{5/4}}$$

Where,

N_s = specific speed

N = speed of actual turbine

P = developed power or shaft power

H = head under which the turbine is working

Unit speed: Unit speed is defined as the speed of a turbine working under a unit head.

$$\text{Unit speed, } N_u = \frac{N}{\sqrt{H}}$$

Where,

N = speed of a turbine under a head H

H = Head under a turbine is working

7. (a) Discuss the usages of power screws and keys in the transmission of load.

6

Solution: Usages of power screw: A power screw is a drive used in machinery to convert a rotary motion into a linear motion for power transmission. Power screws should be designed

for smooth and noiseless transmission of power with an ability to carry heavy loads with high efficiency. It produces uniform motion.

Power Screws are used due to the following reasons:

- Can obtain high mechanical advantage in order to move large loads with a minimum effort. e.g screw jack.
- To generate large forces e.g tensile test machine, compactor press.
- To obtain precise axial movements e.g. camera calibration rigs.

Usage of keys: Keys are used in machine construction to prevent a machine part, such as a gear or a pulley, from rotating relative to the shaft on which it is mounted. A common type of key is a square bar that fits half in a groove (keyway) in the shaft and half in an adjoining keyway in the component.

(b) What are the causes of failure of riveted joints? Explain.

6

Answer: Some common causes of failure of riveted joints are -

Tearing of the plate at the edge: A joint may fail due to the tearing of the plate at an edge. Such a failure occurs due to insufficient margin. This can be avoided by keeping the margin, $m = 1.5d$, where d is the diameter of the rivet hole.

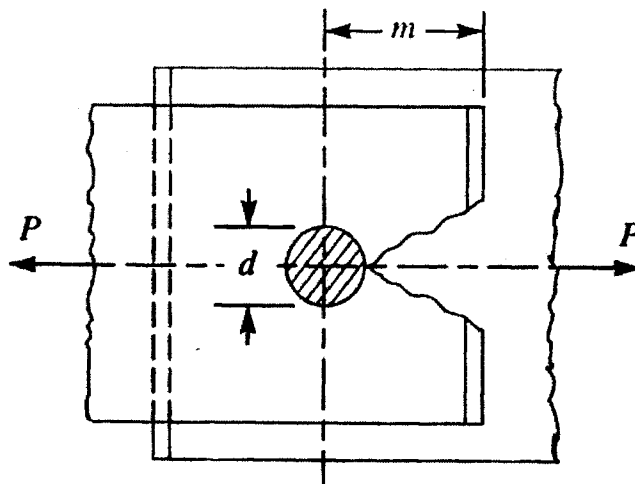


Figure: Tearing of the plate at the edge

Tearing of the plate across a row of rivets: Due to the tensile stresses in the main plates, the main plate or cover plates may tear off across a row of rivets as shown in Fig. below. In such cases, we consider only one pitch length of the plate, since every rivet is responsible for that much length of the plate only. The resistance offered by the plate against tearing is known as tearing resistance or tearing strength or tearing value of the plate.

When the tearing resistance (P_t) is greater than the applied load (P) per pitch length, then this type of failure will not occur.

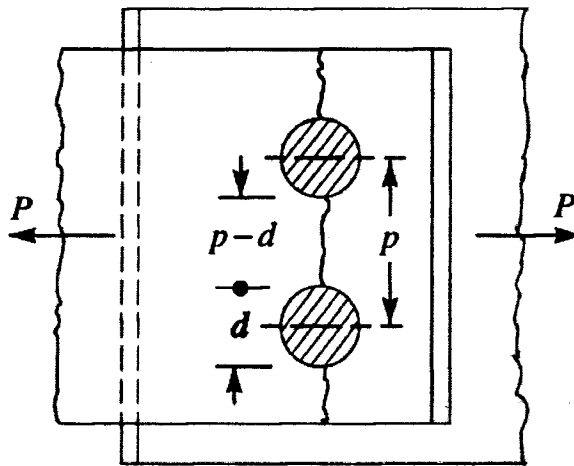
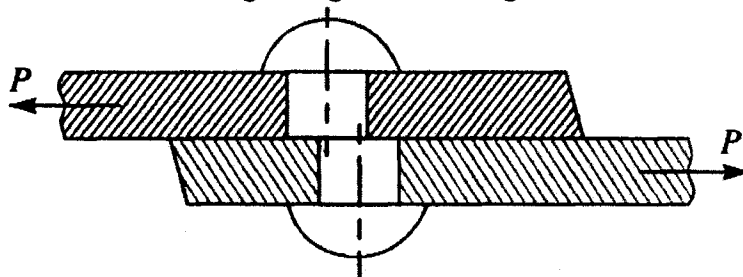
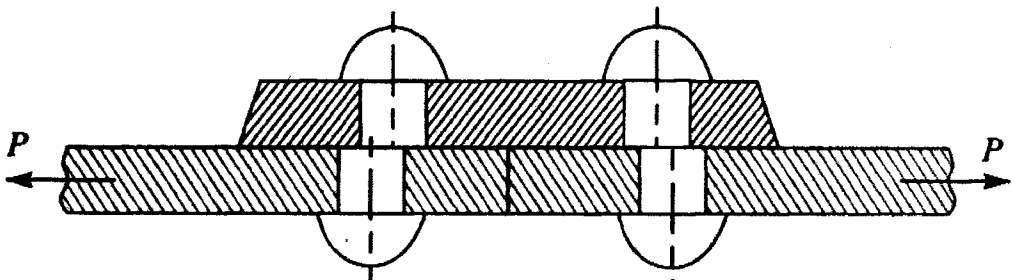


Figure: Tearing of the plate across a row of rivets

Shearing of rivets: It may be noted that the rivets are in *single shear in a lap joint and in a single cover butt joint, as shown in Fig. (i). But the rivets are in double shear in a double cover butt joint as shown in Fig. (ii). The resistance offered by a rivet to be sheared off is known as shearing resistance or shearing strength or shearing value of the rivet.



(a) Shearing off a rivet in a lap joint.



(b) Shearing off a rivet in a single cover butt joint.

Figure (i): Shearing of rivets

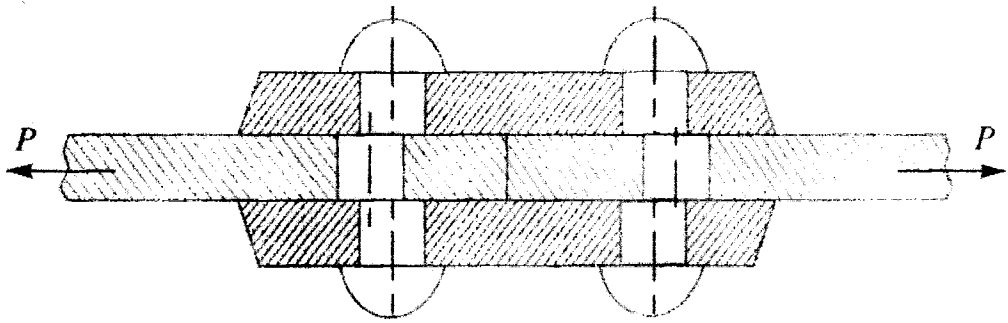


Figure (ii): Shearing off a rivet in double cover butt joint.

Crushing of rivets: Sometimes, the rivets do not actually shear off under the tensile stress, but are crushed as shown in Fig. below. Due to this, the rivet hole becomes of an oval shape and hence the joint becomes loose. The failure of rivets in such a manner is also known as bearing failure. The area which resists this action is the projected area of the hole or rivet on diametral plane. The resistance offered by a rivet to be crushed is known as crushing resistance or crushing strength or bearing value of the rivet.

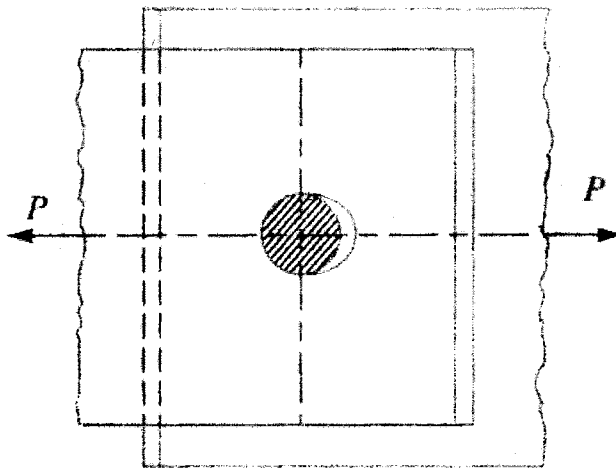


Figure: Crushing of rivet

(c) A body is subjected to two normal stresses 20 kN/m^2 (tensile) and 10 kN/m^2 (compressive) acting perpendicular to each other. What is the maximum shear stress?

Solution: We know, maximum shear stress, $\tau_{\max} = \frac{\sigma_1 - \sigma_2}{2}$

$$= \frac{20 - (-10)}{2} = 15 \text{ kN/m}^2 \text{ (Answer)}$$

Part II

Marks: $20 \times 4 = 100$

8. (a) Explain with neat sketches free and forced vibration.

6

Answer: “Fundamentals of Mechanical Engineering vol.1, chapter-8”

(b) Discuss briefly the effects of gyroscope couple on an aeroplane and a naval ship. **4**

Answer: Effects of gyroscope couple on an aeroplane:

1. When the engine or propeller of an aeroplane rotates in the clockwise direction when seen from the rear or tail end and the aeroplane takes turn to the left, then the effect of gyroscopic couple will be to raise the nose and dip the tail of the aeroplane.
2. When the aeroplane takes a right turn under similar conditions as discussed above, the effect of the gyroscopic couple will be to dip the nose and raise the tail of the aeroplane.
3. When the engine or propeller rotates in anticlockwise direction when viewed from the rear or tail end and the aeroplane takes a left turn, then the effect of the gyroscopic couple will be to dip the nose and raise the tail of the aeroplane .
4. When the aeroplane takes a right turn under similar condition as mentioned in note 3 above, the effect of gyroscopic couple will be to raise the nose and dip the tail of the aeroplane.
5. When the engine or propeller of an aeroplane rotates in the clockwise direction when viewed from the front and the aeroplane takes a left turn, the effect of gyroscopic couple will be to raise the tail and dip the nose the aeroplane.
6. When the aeroplane takes a right turn under similar conditions as mentioned in note 5 above, the effect of gyroscopic couple will be to raise the nose and dip the tail of the aeroplane.

Effects of gyroscopic couple on a naval ship:

1. Steering: The steering is the turning of a complete ship in a curve towards left or right, while it moves forward. When the rotor of a ship rotates in the clockwise direction when viewed from the stern and the ship during steering takes a left turn, then the effect of gyroscopic couple will be to raise the bow and lower the stern.

Notes: (i). When the ship steers to the right under similar conditions as discussed above, the effect of gyroscopic couple will be to raise the stern and lower the bow.

(ii) When the rotor rotates the anticlockwise direction, when viewed from the stern and the ship is steering to the left, then the effect of gyroscopic couple will be to lower the bow and raise the stern

(iii) When the ship is steering to the right under similar conditions as discussed in note (ii) above, then the effect of gyroscopic couple will be to raise the bow and lower the stern

(iv) When the rotor rotates in the clockwise direction when viewed from the bow or fore end and the ship is steering to the left, then the effect of gyroscopic couple will be to raise the stern and lower the bow.

(v) When the ship is steering to the right under similar conditions as discussed I note (iv)

above, then the effect of gyroscopic couple will be to raise the bow and lower the stern.

(vi) The effect of gyroscopic couple on a boat propelled by a turbine taking left or right turn is similar as discussed above.

2. Pitching: The pitching is the movement of a complete ship up and down in a vertical plane about transverse axis. When the pitching is upward, the effect of the gyroscopic couple will try to move the ship towards star-board. On the other hand, if the pitching is downward, the effect of gyroscopic couple, is to turn the ship towards port side.

3. Rolling: In case of rolling of a ship, the axis of precession is always parallel to the axis of spin for all positions. Hence, there is no effect of the gyroscopic couple acting on the body of a ship.

(c) There are six gears A, B, C, D, E & F are in a compound gear train. The numbers of teeth of the gears are 20, 60, 30, 80, 25 and 75. What is the angular speed ratio of the driver (F) to the driver (A) of the device? 10

Solution: Given; $T_A = 20$, $T_B = 60$, $T_C = 30$, $T_D = 80$, $T_E = 25$, $T_F = 75$

Let, Speed of gear A = N_A , Speed of gear B = N_B , Speed of gear C = N_C , Speed of gear D = N_D , Speed of gear E = N_E , Speed of gear F = N_F

We know the speed ratio of compound gear train is;

$$\frac{N_A}{N_B} \times \frac{N_C}{N_D} \times \frac{N_E}{N_F} = \frac{T_B}{T_A} \times \frac{T_D}{T_C} \times \frac{T_F}{T_E}$$

Here; $N_B = N_C$ and $N_D = N_E$

$$\text{So } \frac{N_A}{N_F} = \frac{60 \times 80 \times 75}{20 \times 30 \times 25} = 24$$

$$\frac{N_F}{N_A} = \frac{1}{24}$$

$$\text{Angular speed of driven gear F, } w_F = \frac{2\pi N_F}{60}$$

$$\text{Angular speed of driver gear A, } w_A = \frac{2\pi N_A}{60}$$

$$\therefore \text{Angular speed ratio of driven (F) to driver(A) } \frac{w_F}{w_A} = \frac{\frac{2\pi N_F}{60}}{\frac{2\pi N_A}{60}} = \frac{N_F}{N_A} = \frac{1}{24} \text{ (Answer)}$$

9. (a) Explain the phenomenon of pre-ignition. How pre-ignition leads to detonation and vice-versa in an internal combustion engine? 6

Answer: Pre-ignition phenomena:

Pre-ignition is the ignition of the charge in spark ignition engine before the spark occurs in the spark plug. Or, pre-ignition is the spontaneous combustion of the mixture before the end of the compression stroke. The ignition source can be caused by a cracked spark plug tip, carbon or lead deposits in the combustion chamber, or a burned exhaust valve, anything that can act as a glow plug to ignite the charge prematurely.

From pre-ignition to detonation or vice versa:

Engines can tolerate detonation for substantial periods of time, but there is no engine that can survive for very long when pre-ignition occurs. The engine will not run for more than a few seconds with pre-ignition.

Although detonation and pre-ignition are two completely different phenomena, it is

possible for heavy detonation to induce pre-ignition. If the engine is operating in heavy detonation for a significant period of time, the excessive temperatures and pressure spikes (which disturb the usual protective boundary layer) can cause spark plug electrodes and other things in the combustion chamber to overheat to the point where they start to glow red hot. At that point, the glowing item can cause pre-ignition and rapid destruction of the cylinder.

(b) Define octane number.

4

Answer: Octane number denotes the percentage (by volume) of iso-octane in a combustible mixture containing iso-octane and normal-heptane. It is a number that is used to measure the antiknock properties of a liquid motor fuel (such as gasoline) with a higher number indicating a smaller likelihood of knocking.

(c) Why is refrigeration and reheating is done in the gas turbine power cycle?

5

Answer: "Fundamentals of Mechanical Engineering vol.1, chapter-5"

(d) What are the sources of energy in Bangladesh that are used for power production?

5

Answer:

Fuel Type	Installed Capacity(Unit)	Total (%)
Coal	1768.00 MW	8.05 %
Gas	11352.00 MW	51.68 %
HFO	6044.00 MW	27.51 %
HSD	1290.00 MW	5.87 %
Hydro	230.00 MW	1.05 %
Imported	1160.00 MW	5.28 %
Solar	123.00 MW	0.56 %

10.(a) What is meant by convection heat transfer? Discuss the physical mechanism of natural convection.

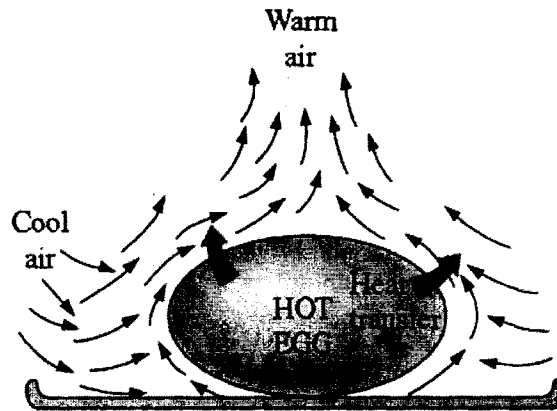
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Answer: Convection heat transfer:

Convective heat transfer, often referred to simply as convection, is the transfer of heat from one place to another by the movement of fluids. Convection is usually the dominant form of heat transfer in liquids and gases.

Physical mechanism of natural convection:

The motion that results from the continual replacement of the heated air in the vicinity of the egg by the cooler air nearby is called a **natural convection current**, and the heat transfer that is enhanced as a result of this natural convection current is called **natural convection heat transfer**.



The cooling of a boiled egg in a cooler environment by natural convection.

(b) Why ducts are used in Air conditioning system?

5

Answer: A duct system is a passage for air flow so ducts deliver either warm or cool air to all areas of your home and helps in ventilating your home completely. Ducts have two main types of air flow:

- Supply air– this is outside air that gets drawn inside.
- Return air– this is inside air that gets brought back outside.

The supply and return ducts serve as a pathway for air so that it can be circulated throughout the home.

When the thermostat indicates that the temperature needs to be turned down, the return air ducts pull in warm air from inside and passes that air through a filter that removes airborne particles. Then this air moves right back to the supply air ducts where it is delivered as cool air back into the house.

(c) Classify central air conditioning system. Also list the selection criteria for air conditioning system.

5

Answer: Classification of central air conditioning system:

The central station air conditioning systems are classified according to cooling medium used to transport thermal energy to or from the air conditioned space. The main types of cooling medium used in central air-conditioning system are

1.All-air system

All-air systems transfer cooled or heated air from a central plant via ducting, distributing air through a series of grilles or diffusers to the room or rooms being served.

2.All-water system

In the system, both sensible and latent space cooling are achieved by chilled water obtained from central refrigeration system through the cooling coils in terminal units located in various spaces in the building.

3.Air-water system

In an air water system, both air and water are distributed to each air conditioned space to create a cooling effect.

Selection criteria for air conditioning system:

- Capacity, performance & spatial requirements
- Initial and running costs
- Required system reliability and flexibility
- Maintainability
- Architectural constraints

The relative importance of the above factors may vary from project to project.

(d) What are the different factors considered in load estimation sheet for comfort application? 5

Answer: Factors considered in load estimation sheet for comfort application:

1. Load estimate sheets are designed for limited application with respect to building type, construction, internal heat gains and exposure.
 2. Application of load forms requires estimates of time peak loads or range of time of peak loading.
 3. Commercial load forms are based on significant internal heat gains and relatively lower external heat gain. Do not use residential forms for commercial applications and vice-versa.
 4. FW sunlit windows, doors and walls :
 - a. Determine the exposure at peak load time.
 - b. In calculating the solar load, orientation of wall is Critical.
 - c. Walls--use wall area exposed to sun during the day.
 5. Transmission gain for walls, windows, doors and partition :
 - a. Area to include all windows exposed to outside air.
 - b. Partitions may be considered as shaded walls if no factor is listed. Partitions exposed to unusual conditions such as kitchen, boiler room etc, may be handled by multiplying partition factors by 2, if no special allowance factor is listed.
 6. Internal heat gains
 - a. Evaluate occupancy load carefully
 - b. Adequate exhaust and hoods over appliances may reduce the loads from these appliances by as much as 50%
 - c. Careful consideration should be given for lighting load, frequently this is the major internal load particularly in office space or brilliantly lighted stores.
- 11.(a) What is work sampling? Explain the steps of work sampling.** 6

Answer: Work sampling: Work sampling is the statistical technique used for determining the proportion of time spent by workers in various defined categories of activity (e.g. setting up a machine, assembling two parts, idle...etc.). It is as important as all other statistical techniques because it permits quick analysis, recognition, and enhancement of job responsibilities, tasks, performance competencies, and organizational work flows. Other names used for it are 'activity sampling', 'occurrence sampling', and 'ratio delay study'.

In a work sampling study, a large number of observations are made of the workers over an extended period of time. For statistical accuracy, the observations must be taken at random

times during the period of study, and the period must be representative of the types of activities performed by the subjects.

One important usage of the work sampling technique is the determination of the standard time for a manual manufacturing task. Similar techniques for calculating the standard time are time study, standard data, and predetermined motion time systems.

There are several recommended steps when starting to prepare a work sampling study:

- Define the manufacturing tasks for which the standard time is to be determined.
- Define the task elements. These are the defined broken-down steps of the task that will be observed during the study. Since a worker is going to be observed, additional categories will likely be included as well, such as "idle", "waiting for work", and "absent".
- Design the study. This includes designing the forms that will be used to record the observations, determining how many observations will be required, deciding on the number of days or shifts to be included in the study, scheduling the observations, and finally determining the number of observers needed.
- Identify the observers who will do the sampling.
- Start the study. All those who are affected by the study should be informed about it.
- Make random visits to the plant and collect the observations.
- After completing the study, analyze and present the results. This is done by preparing a report that summarizes and analyzes all data and making recommendations when required.

(b) State the difference between quality control and inspection.

6

Answer:

Parameters	Inspection	Quality control
Scope	Part of QC	Broad term, Inspection at particular stage
Definition	Checking of material, product or components of product at various stages, with reference to certain pre-determined factors and detecting and sorting out the faulty or defective items.	Effective system for integrating quality development, quality maintenance and quality improvement efforts of various groups in an organization to enable the production to be carried out at most economical level
Devices used	Precision measuring instruments such as vernier calipers, micrometers, profile projectors etc.	Statistics, control charts, acceptance sampling, process capability study, V. R., quality audits etc.
Applicability	Concerned with quality of past production	Concerned with quality of future production.
Concern	Mainly the responsibility of inspectors	Everybody working in the organization is responsible.

(c) What is control chart? Discuss the rule of control charts in manufacturing process. 8

Answer: Control Chart: The control chart is a graph used to study how a process changes over time. Data are plotted in time order. A control chart always has a central line for the average, an upper line for the upper control limit, and a lower line for the lower control limit. These lines are determined from historical data. By comparing current data to these lines, you can draw conclusions about whether the process variation is consistent (in control) or is unpredictable (out of control, affected by special causes of variation).

Rule of control charts in manufacturing process:

If a process is in statistical control, most of the points will be near the average, some will be closer to the control limits and no points will be beyond the control limits. The 8 control chart rules listed in table below give indications that there are special causes of variation present. Again, these represent patterns.

Table 1: Control Chart Rules

Rule	Rule Name	Pattern
1	Beyond Limits	One or more points beyond the control limits
2	Zone A	2 out of 3 consecutive points in Zone A or beyond
3	Zone B	4 out of 5 consecutive points in Zone B or beyond
4	Zone C	7 or more consecutive points on one side of the average (in Zone C or beyond)
5	Trend	7 consecutive points trending up or trending down
6	Mixture	8 consecutive points with no points in Zone C
7	Stratification	15 consecutive points in Zone C
8	Over-control	14 consecutive points alternating up and down

It should be noted that the numbers can be different depending upon the source. For example, some sources will use 8 consecutive points on one side of the average (Zone C test) instead of the 7 shown in the table above.

12.(a) Describe briefly different allowances in making patterns for casting. 6

Answer: There are five types of casting allowances are there, and those are:

- 1. Shrinkage Allowance:** During cooling of the material in the Casting process, in all the three stages, the material is getting shrinking (reducing its dimensions or volume). But, shrinkage allowance taking place in 1st two stages is called Liquid Shrinkage.
- 2. Machining Allowance:** The extra dimension provided on the casting and it will be removed by machining after the casting has been completed is called Machining Allowance.
- 3. Draft Allowance:** Making the vertical surfaces of the pattern into inclined surfaces is called Draft Allowance.
- 4. Shake Allowance:** A pattern is shaken or rapped by striking the same with a wooden piece from side to side. This is done so that the pattern a little is loosened in the mold cavity and can be easily removed. In turn, therefore, rapping enlarges the mould cavity which results in a bigger sized casting.
- 5. Distortion Allowance:** When casting of very thin surfaces like V Shape, U shape etc. it will distort or damage during pattern removal or during casting. To avoid this problem, a chamber is provided on pattern to compensate distortion during pattern removal. This change in casting dimension is known as distortion allowance.

(b) Differentiate permanent mold casting and die casting.

6

Answer: In permanent mold casting, metal flows into the cavity from a reservoir. A gate controls the speed of flow to reduce turbulence. Typically, the die will be designed to fill from the bottom or side with the riser at the highest point.

After filling, the metal is given time to freeze before the mold is opened and the part removed. Features such as internal galleries are created by placing inserts into the mold before it is closed.

In contrast to gravity-fed permanent mold casting, with die casting, metal is forced into the cavity under pressure. This makes it very similar to plastic injection molding. As with permanent mold casting, once the metal solidifies, the mold opens and the cast forms are removed.

(c) Describe briefly one non-destructive test for detection of weld defects.

8

Answer: The most common non-destructive tests to check welds are Visual Inspection, Liquid Penetrant, Magnetic Particle, Eddy Current, Ultrasonic, Acoustic Emission and Radiography.

Out of these non-destructive tests, liquid penetrant inspection is described.

Liquid or Dye Penetrant Inspection: As the name suggests a coloring agent is used to detect weld defects. This method will only find surface cracks and surface discontinuities. The weld surface is thoroughly cleaned of scale and splatter (but not shot blasted as it will close over the defects). A detergent wash is used to remove dirt, a pickling paste is used to remove paint or grease and a degreaser or solvent is applied to remove oil. Only a clean

metal surface is acceptable.

The system normally comes in two spray cans – one is the penetrant and the other is the developer. The penetrant is sprayed over the weld and capillary action draws it into any minute surface cracks. The penetrant on the surface is wiped off and the penetrant in the cracks remains wet. After a short dwell time the developer is sprayed over the weld. The developer acts to draw-out the penetrant dye from the cracks and so changes color. It behaves like blotting paper and magnifies the presence of the crack.

13.(a) Define the following machining operation:

6

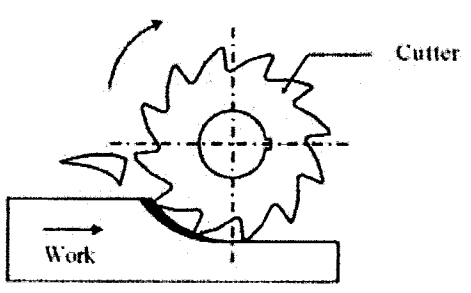
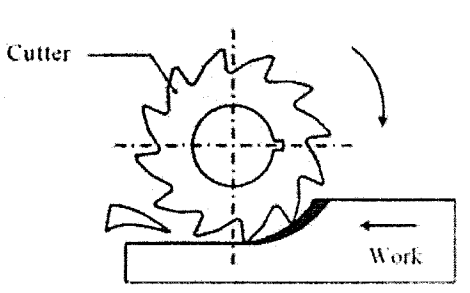
(i) boring (ii) drilling (iii) reaming

Answer: See Fundamentals of Mechanical Engineering Vol.1, chapter-10.

(b) Differentiate between up milling and down milling operation.

6

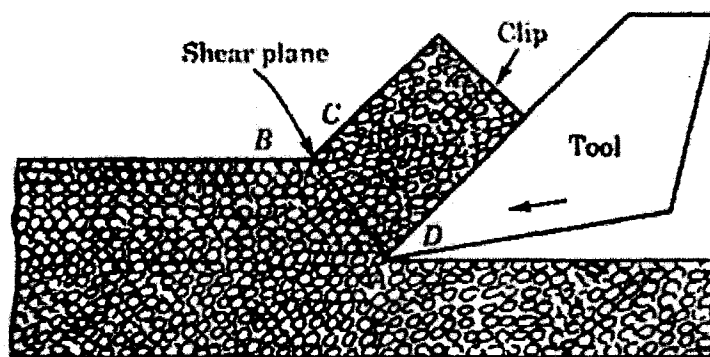
Answer: Difference between up milling and down milling operation is given below

Up milling	Down milling
Cutter teeth moves in a direction opposite to the direction of feed of work piece	Cutter teeth moves in a direction same as the feed of the work piece
It is an ancient method of machining	It is a modern method of machining
It tends to lift the work piece from fixture	It does not tend to lift the work piece from fixture
Cutter force is higher at the end of the cut	Cutter force is higher at the beginning of the cut
Chip thickness is highest at the end	Chip thickness is highest at the beginning
The cutter has strong rubbing action	The cutter has small rubbing action
This method is less effective	This method is more effective
Surface finish is weaker than down milling	Surface finish is higher.
 <p style="text-align: center;">Upmilling</p>	 <p style="text-align: center;">Downmilling</p>

(c) Describe the chip formation in metal cutting.

8

Answer: In any machining operation, the material is removed from the work piece in the form of chips, the nature of which differs from operation to operation. Chips are formed due to tearing and shearing. In the process of chip formation by tear, the work piece material adjacent to tool face is compressed and a crack runs ahead of cutting tool and towards the body of the work piece. The chip is highly deformed and work piece material is relatively under-formed. Cutting takes place intermittently and there is no movement of the work-piece material over the tool face. In chip formation by shear, there is general movement of the chip over tool face. As the tool advances into the work-piece, the metal ahead of the tool is severely stressed. The cutting tool causes internal shearing action in the metal, such that the metal below the cutting edge yields and flows plastically in the form of chip. Firstly compression of the metal under the tool edge takes place and then follows separation of metal, when compression limit of that metal has been exceeded. Plastic flow takes place in a localized region called shear plane, which extends from the cutting edge obliquely upto the uncut surface ahead of the tool. When the metal is sheared the crystals are elongated, the direction of elongation being different than from that of the shear. It may be mentioned that the deformation of metal in the process of separation of chip, does not occur sharply across the shear-plane. The grains of the metal ahead of cutting edge of tool start elongating along the line AB and continue to do so until they are completely deformed along the line CD. The region between the lines AB and CD is called shear-zone. After passing out the shear-zone, the deformed metal slides along the tool face due to the velocity of the cutting tool. For all mathematical analysis this shear zone is treated as a plane and is called a shear-plane. The angle made by plane of shear with the direction of tool travel is known as shear angle (ϕ). Its value depends on the material being cut and the cutting conditions. If (ϕ) is small, path of shear will be long, chips will be thick, and the force required to remove the layer of metal of given thickness will be high and vice versa.



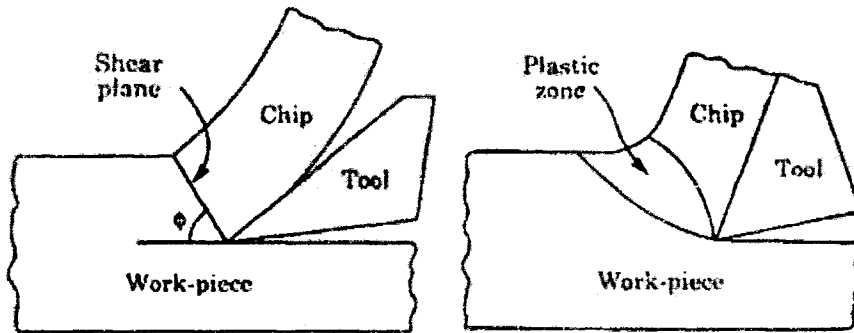


Fig: Chip formation Process

14.(a) Give a definition of organization and put forward the classification of organization structures with relative merits and demerits. 8

Answer: Organization: Organization is the process so combining the work which individuals or groups have to perform with the facilities necessary for its execution, that the duties so performed provide the best channels for the efficient, systematic, positive and coordinated application of the available effort.

Organizational structure is mainly classified into 3 types

1. Functional
2. Divisional
3. Matrix

Functional organizational structure: Authority is determined by the relationship between group function and activities.

Advantages

- The team is managed by an experienced person with a high ability and skills who can adequately understand and review the entire work.
- The team members work with other people in the field and it allows sharing of thoughts and knowledge to make the people learn new skills.
- The staffers have the chance to get promoted within their functional areas which can be a reason for them to stay long term. The company is getting the advantage of their expertise and knowledge.
- Because of people's expertise, the workers with specialized skills can perform tasks quickly, efficiently and with more confidence, while reducing of work-related mistakes
- This can be an ideal structure for small businesses that focus on one product or service because you can maximize performance by encouraging peer cooperation among different units at various levels of management through supervision and coordination.

Disadvantages:

- The functional organization may have unhealthy competition working with the other areas. There may be a lack of understanding as to how significant that specific are to the company.
- Because the people in the functional organization are grouped according to their

special set of skills, roles or task, the entire team will operate well. However, the business strategies and the level of bureaucracy make it difficult to respond to changes immediately.

- Another disadvantage of functional organization structure is that these functional groups may not be able to communicate more often which decreases flexibility and innovation

Divisional organizational structure: Corporate division operates as autonomous business under the large corporate umbrella.

Advantages:

- Each division can work as an independent unit.
- Each division gets adequate freedom.
- Division managers become experts in their area.
- Separation of strategies and operating control.
- Good training ground for strategic management.
- This structure can create career development chances.
- Remove the need for direct supervision of division by corporate managers.
- Timely and effective decisions can be taken.
- Retain function specialization within each division.
- Frees chief executive officer for border strategic decision making

Disadvantages:

- This structure is not suitable for small organizations.
- Headquarters find it difficult to control each division.
- Duplication of activities may happen in different divisions.
- Can be very expensive, When each division is engaged in independent service cost may increase
- When each divisional manager safeguards his interest alone, he/she ignores the common goal of the organization.
- The conflict between the divisional head.
- Can focus on short term performance.

Matrix organizational structure: A matrix structure is that organizational structure that assigns specialists from different functional department to work on one or more project.

Advantages:

- Collaboration between different departments
- Combines project and functional management structures
- Allows interdepartmental communication
- Employees can develop new skills
- Team members and managers keep their functional roles

Disadvantages:

- Managerial roles may not be clearly defined.
- Team roles may not be clearly defined.
- The decision-making process can be slowed down.

- Too much work can cause overload.
- Measuring employee performance might become difficult

(b) Define management and administration.

5

Answer: Management: Organization and coordination of the activities of an enterprise in accordance with certain policies and in achievement of clearly defined objective is management. Management means conducting and directing.

In other words management is the organizational process that includes

- Strategic planning
- Setting objectives
- Managing resources
- Deploying the human and financial asset needed to achieve objectives
- Measuring results

The functions that management performs are:

1. Planning
2. Organizing
3. Leading
4. Controlling

Administration: administration refers to the group of individuals who are in charge of creating and enforcing rules and regulations, or those in leadership positions who complete important tasks.

The main responsibility of an administration is to ensure the efficient performance of all departments in an organization. It acts as a connecting link between the senior management and the employees. Administration provides motivation to the work force and makes them realize the goals of the organization.

(c) Name the major functions of personnel management and describe them in short.

7

Answer: Major functions of personnel management is classified into 2 types:

1. Managerial function
2. Operative function

Managerial function: The Managerial functions of a personnel management involve planning, organizing, staffing, directing, coordinating, reporting and budgeting of those who actually perform the operative functions of the personnel department.

Personnel Planning:

Planning lays down a pre-determined course to do something such as what to do, how to do, where to do, who is to do etc. A personnel manager plans in advance the trend in wages, labour market, union demands etc. Through planning, most of the future problems can be anticipated.

Organizing:

The personnel manager has to design the structure of relationships among jobs, personnel and physical factors so that the objectives of the enterprise are achieved.

Directing

This function relates to guidance and stimulation of the subordinates at all levels. The personnel manager directs and motivates the employees of his department so that they work willingly and effectively for the achievement of organizational goals

Controlling:

A personnel manager has to constantly watch whether there is any deviation from the planned path. Controlling is concerned with remedial actions. Continuous monitoring of the personnel policies relating to training, labour turnover, wage payments, interviewing new and separated employees etc.

Operative function: The operative functions of the personnel management department are also called service functions. These include

- (a) Procurement function
- (b) Development
- (c) Promotion, transfer and termination function
- (d) Compensation function
- (e) Welfare function
- (f) Collective bargaining function

40th BCS

Subject Code: 901

Full Marks: 200

Time: 4 hours

[N.B. Answer any **five** questions from each part. Figures in right margin indicate full marks]**Part I**Marks: $20 \times 5 = 100$

Marks

1. (a) State three laws of thermodynamics.

5

Zeroth Law of Thermodynamics: When two systems are each in thermal equilibrium with a third system, then the two systems are also in thermal equilibrium with one another.

First Law of Thermodynamics: a) The heat and mechanical work are mutually convertible.
i.e. $\oint dQ = \oint dW$

b) The energy can neither be created nor destroyed though it can be transformed from one to another form. i.e. $\delta Q - \delta W = \delta E$

Second Law of Thermodynamics:

Kelvin-Planck Statement: It is impossible to construct an engine working in a cyclic process whose sole purpose is to convert heat energy into an equivalent amount of work.

Clausius Statement: It is impossible for a self-acting machine working in a cyclic process to transfer heat from a body at a lower temperature to a body at a higher temperature without the aid of an external agency.

(b) How will you get the concept of internal energy from the first law of thermodynamics? 5

Answer: The first law of thermodynamics is a statement of the relationship between heat, work and energy stored in a system. A common expression of the law is

$$Q = \Delta E + W$$

Where, Q = heat transferred to system during a process

W = work transferred from system during a process

ΔE = change in internal energy of system during the process

This equation does not contain an expression for the internal energy E explicitly, but contains the change in internal energy. It can be shown that E , the internal energy, is a property of a system and varies with the condition or state of the system. If an arbitrary or reference value of E is assigned to a particular state, it is possible to determine the values at all other states by the application of the above equation. Knowledge of the absolute value of E is not required to apply the principle of energy conservation.

Internal energy may be present in any of a number of kinetic and potential energy forms at macroscopic, molecular and atomic levels. For a system composed of a substance of uniform chemical composition and excluding kinetic and gravitational potential energy, the first law can be expressed as

$$Q = \Delta U + W$$

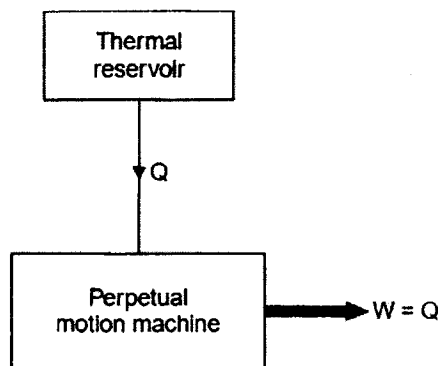
Where, U is, for a pure substance, an expression of internal energy that excludes kinetic and gravitational potential energy as well as other energies associated with surface tension electrical or magnetic effects. Changes in internal energy U are associated with changes in

temperature and changes of phase. Internal energy U is an extensive property in that at any given state, it is proportional to the mass of the system.

We can see that a duality of concepts exists because we cannot define the internal energy without accepting the validity of the first law, but at the same time, to express the first law, we must postulate the existence of this type of energy. Thus the internal energy and the first law of thermodynamics constitute a single concept because they cannot be made independent of each other.

(c) Explain diagrammatically the perpetual motion machine of the second kind. 5
How does it violate the second law of thermodynamics?

Answer: Perpetual motion machine of second kind (PMM2) is that imaginary machine which would continuously absorb heat from a single thermal reservoir and convert this heat completely into work. The efficiency of such a machine would be 100%.



Perpetual Motion Machine of the second kind or 100 percent efficient machine which is impossible to obtain in actual practice, because no machine can convert whole of the heat energy supplied to it, into its equivalent amount of work.

For the satisfactory operation of a heat engine which is a device used for converting heat energy into mechanical work, there should be at least two reservoirs of heat one at a higher temperature and the other at a lower temperature. If there is only the high temperature reservoir, which is being spontaneously cooled without involving a transfer of heat to a cooler reservoir. This conversion of heat into useful work, without any side effect, is impossible, according to the second law of thermodynamics.

Thus, Perpetual Motion Machine of the second kind attempt to violate the second law of thermodynamics—namely, that some energy is always lost in converting heat into work.

(d) 1Kg of ideal gas is heated from 18.3°C to 93.4°C. Assuming $R=0.264$ KJ/KgK and $\gamma = 1.18$ for the gas, find (i) specific heats (ii) changes in internal energy and enthalpy. 5

Solution:

Given, $m = 1\text{Kg}$, $T_1 = 18.3^\circ\text{C} = 291.3\text{K}$; $T_2 = 93.4^\circ\text{C} = 366.4\text{K}$, $R=0.264$ KJ/KgK, $\gamma = 1.18$

(i) specific heats:

We get, $C_p - C_v = R$, $\Rightarrow C_p - C_v = 0.264$

Again, $C_p = \gamma C_v$

$$\therefore \gamma C_v - C_v = 0.264$$

$$\Rightarrow C_v = \frac{0.264}{0.18} = 1.47 \text{ (Answer)}$$

$$\therefore C_p = \gamma C_v = 1.18 \times 1.47 = 1.73 \text{ KJ/KgK (Answer)}$$

(ii) changes in internal energy and enthalpy:

Change in internal energy, $\Delta U = mC_v(T_2 - T_1) = 1 \times 1.47 \times (366.4 - 291.3) = 110.4 \text{ KJ}$
(Answer)

Change in internal energy, $\Delta U = mC_p(T_2 - T_1) = 1 \times 1.73 \times (366.4 - 291.3) = 130.0 \text{ KJ}$
(Answer)

2. (a) Differentiate between fire-tube and water tube type boilers. Which type of 7
boilers is used for power generation and why?

Water Tube Boiler	Fire Tube Boiler
a) The water circulates inside the tubes which are surrounded by hot gases from the furnace.	a) The hot gases from the furnace pass through the tubes which are surrounded by water.
b) It generates steam at a highest pressure upto 165bar.	b) It can generate steam only upto 24.5 bar.
c) The rate of generation of steam is high i.e. upto 450 tonnes per hour.	c) The rate of generation of steam is high i.e. upto 9 tonnes per hour.
d) For a given power, the floor area required for the generation steam is less, i.e. about 5 m ² per tonne per hour of steam generation.	d) For a given power, the floor area required for the generation steam is less, i.e. about 8 m ² per tonne per hour of steam generation.
e) Overall efficiency will economizer is upto 90%.	e) Overall efficiency will economizer is upto 75%.
f) It can be transported and erected easily as its various parts can be separated.	f) The transportation and erection is difficult.
g) It is preferred for widely fluctuating loads.	g) It can also cope reasonably with sudden increase in load but for a shorter period.
h) The direction of water circulation is well defined.	h) The water does not circulate in a definite direction.
i) The operating cost is very high.	i) The operating cost is less.
j) The bursting changes are more.	j) The bursting changes are less.
k) The bursting does not produce any destruction to the whole boiler.	k) The bursting produces greater risk to the damage of the property.
l) It is used for large power plants.	l) It is not suitable for large power plants.

- Water tube boilers are used at power plants because of its high efficiency and high steam production rate.

(b) What are reasons for the explosion of boilers? Suggest some remedial measures to prevent boiler explosion. 7

Answer: Boiler Explosion Causes:

Boiler explosion occurs not only due to boiler accidents. Many other factors involved in a boiler explosion. Some of the main boiler explosion causes are the following:

- Design faults
- Construction faults
- Corrosion
- Unskilled boiler attendant
- Improper water treatment
- Boiler pressure increases from design pressure
- Overheating of tubes due to low water level
- Faulty safety valves and other mountings

Boiler explosion causes are different in different types of boilers. Some of the main and common causes discuss here.

- If boiler feed water has acidic properties, then corrosion occurs in shell, plates, and stays. In a smoke tube boiler, firebox plates will collapse due to corrosion.
- Grooving in boilerplates decreases the strength of plates. Weak plates also a major factor of a boiler explosion. Grooving occurs in the boiler where plates circle is improper and expansion and contraction also improper. The mostly grooving fault occurs near joints.
- External corrosion also involves in a boiler explosion. Leakage in flanges and tubes is the main reason of external corrosion. An excessive amount of sulfur in fuel also causes corrosion. This corrosion weakens the plates and results as a boiler explosion.
- External deposition of soot's also caused corrosion.
- Due to Boiler overheating, plates will burst or collapse. Low water level, improper water circulation, and deposition of scales are the major factors of overheating. Overheating leads to boiler explosion causes. Lancashire, Marine and Cornish Flu collapse due to overheating. Furnace tubes will also collapse. Combustion chambers tube pledge and formation of steam packets also occur with the help of overheating of boiler. Overall these all factors (overheating) involves an explosion.
- If cold water feed to the overheating tubes than a boiler explosion also occurs due to sudden steam generation.
- Boiler over pressurization also a major cause of a boiler explosion. For example, if a safety valve overloaded for some reason or faulty seat (defective safety valve) increases the chances of explosion.
- Cracks in rivets and joints increase the probability of boiler explosion causes. Improper hole punching, improper use of chisel during boilerplates and riveting cocking, damages the joints. These damaged joints can also explode the boiler. Blustering in boiler tubes also the reason for the explosion.
- In the firebox, improper expansion and contraction between firebox plates and shell

plates create strain in stays. Stays break as a result of strain which causes the boiler explosion.

- Failure of rivet joints also the main cause of the boiler explosion. Following are the reasons for rivet joint failure:
 - Sharing of rivets
 - Plate crack in between rivet line
 - Plate crush in front of rivets
 - Bursting of the plate in front of rivets
 - Cracks in welding joints
- Defective steam boiler fitting and mountings also involve in the explosion Water-tube boiler tubes exploded due to corrosion, pitting and overheating.
- The gas explosion affects the boiler heating surface very badly. If boiler light up without removing unburned gases in the flue gas path, than unburned gases suddenly catches the fire and cause the boiler explosion.

Reference: <https://mechanicallyinfo.com/boiler-explosion-causes/>

Boiler Accident Prevention

Routine maintenance can generally be done by the boiler operator to avoid these devastating accidents. But there are circumstances when a trained professional is needed. These include:

- Leaking safety and/or safety relief valves
- Contaminated feed water
- Steam leaks (in steam boilers)
- High stack temperatures (exceeding 177° C)
- Insufficient heat for the building
- Condensation dripping down the stack or out of the front of the boiler
- Constant resetting of controllers and safety devices
- Ongoing routine maintenance and inspection is the best way to prevent a boiler accident.

Use a checklist when inspecting a boiler to ensure you're inspecting it thoroughly.

Reference:

https://www.academia.edu/34971737/Boiler_explosion_its_causes_and_effects_in_Bangladesh

(c) A throttle governed steam engine develops 15 kW with 280 kg per hour of steam and 35 kW with 520 kg per hour of steam. What will be the steam consumption in kg per hour when develop 20 kW power?

Solution: We get, Steam consumption per hour, $m = a + b \times I.P$

Where, a & b are constants and I.P is the indicated power.

$$\therefore 280 = a + b \times 15 \dots \dots (i)$$

$$\& 520 = a + b \times 35 \dots \dots (ii)$$

From equation (i) & (ii) we get, $a = 100$ & $b = 12$

\therefore Steam consumption when developing 20KW,

$$m = 100 + 12 \times 20 = 340 \text{ Kg/h (Answer)}$$

3. (a) What is meant by steady state and transient heat conduction? What typical examples define periodic and non-periodic variation of temperature change? 5

Answer: Steady-state heat conduction:

It is the form of conduction that happens when the temperature difference(s) driving the conduction are constant.

Transient heat conduction:

During any period in which temperatures changes in time at any place within an object, the mode of thermal energy flow is termed transient conduction.

Typical examples regarding periodic and non-periodic variation of temperature change:

A thermal boundary condition that frequently arises in natural as well as in engineering systems is the periodic change of the temperature of the surrounding medium. The daily and seasonal changes of solar radiation on the soil or on buildings, the periodic temperature changes in the cylinders of internal combustion engines, the (on-off) temperature control by a thermostat, and the periodic heat transfer in a regenerator are examples for this kind of boundary condition.

Changes such as freezing of water, falling of leaves from trees and landslides during the rainy season are non-periodic changes.

(b) State Stefan Boltzman law, Kirchhoff's law and Wein's law of heat transfer? 5

Answer:

Stefan-Boltzmann law:

The radiation energy emitted by a blackbody per unit time and per unit surface area was determined experimentally by Joseph Stefan in 1879 and expressed as

$$E_b(T) = \sigma T^4 \text{ W/m}^2$$

This equation is known as the Stefan-Boltzmann law.

Kirchhoff's law:

It states that the emissivity and the absorptivity of a surface at a given temperature and wavelength are equal.

$$a(\lambda) = e(\lambda)$$

Wien's displacement law:

It states that the black body radiation curve for different temperatures will peak at different wavelengths that are inversely proportional to the temperature.

(c) An electric cable of aluminum conductor ($K_{al}=240\text{W/m}^\circ\text{C}$) is to be insulated with rubber ($k = 0.15 \text{ W/m}^\circ\text{C}$). The cable is to be located in air ($h = 6 \text{ W/m}^2\text{C}$). 6

What is the critical thickness of insulation?

Solution: For cylindrical pipe, the critical radius of insulation is given by

$$r_c = \frac{k}{h_o} = \frac{0.15}{6} = 0.025\text{m} = 25\text{mm} \text{ (Answer)}$$

(d) Two infinite black plates at 800°C and 300°C exchange heat by radiation. 4
Calculate the heat transfer per unit area.

Solution:

 Infinite plate: $T_{sur} = 300^\circ\text{C}$; blackbody ($\epsilon = 1$)

 Infinite plate: $T_s = 800^\circ\text{C}$; blackbody ($\epsilon = 1$)

$$T_s = 800^\circ\text{C} = (800 + 273.15) \text{ K} = 1073.15 \text{ K}$$

$$T_{sur} = 300^\circ\text{C} = (300 + 273.15) \text{ K} = 573.15 \text{ K}$$

From Stephan-Boltzmann law $q'' = \epsilon \sigma (T_s^4 - T_{sur}^4)$

$$\text{NA: } q'' = 1 \times 5.67 \times 10^{-8} (1073.15^4 - 573.15^4) \text{ W/m}^2$$

$$\Rightarrow q'' = 69082 \text{ W/m}^2 = 69.082 \text{ kW/m}^2 \text{ (Answer)}$$

4. (a) Draw the layout of a vapor compression refrigeration system. Using p-h and T-s diagrams describe its working principle. 6

Answer: See at "Fundamentals of Mechanical Engineering Vol.1, chapter-6"

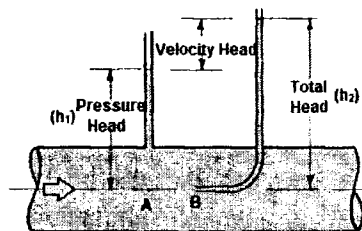
- (b) Sketch a pitot tube and explain how it is used to measure the velocity of a flowing fluid.

Answer:

Pitot tube can be used to measure fluid flow velocity and dynamic pressure difference. A pitot tube is measuring velocity of flow.

Pitot tube is based on principle of conservation of kinetic head into pressure head. The point at which velocity reduces zero is called stagnation point.

Velocity head is indicated by the difference in liquid level between the pitot tube and the piezometer. The pitot tube measure the total head and therefore known as total head tube.



Where, h_1 = static head; h_2 = total head

$$P_A = P_{atm} + h_1 \rho g \text{ and } P_B = P_{atm} + h_2 \rho g$$

Applying Bernoulli's equation,

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + Z_1 = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + Z_2$$

$$\Rightarrow \frac{P_A}{\gamma} + \frac{V_A^2}{2g} = \frac{P_B}{\gamma} ; [V_B = 0; Z_1 = Z_2]$$

$$\Rightarrow \frac{V_A^2}{2g} = \frac{\rho g (h_2 - h_1)}{\rho g}$$

$$\Rightarrow V_A = \sqrt{2gh}$$

(c) Define Reynolds number and Mach number. Explain their physical significance in the analysis of fluid flow problems. 5

Answer: See at “Fundamentals of Mechanical Engineering Vol.1, chapter-4”

(d) Specific gravity of oil is 0.95 and viscosity 0.011 poise. What is the kinematic viscosity in stoke? 4

Solution:

Given: specific gravity=0.95 and viscosity= 0.011 poise.

$$\text{Density of fluid } (\rho) = 0.95 \times 1000 = 950 \text{ kg/m}^3$$

$$\text{Dynamic viscosity } (\mu) = 0.011 \text{ poise} = 0.1 \times 0.011 = 0.0011 \text{ NS/m}^2$$

$$\therefore \text{Kinematic viscosity, } \nu = \frac{\mu}{\rho}$$

$$= \frac{0.0011}{950} = 1.158 \times 10^{-6} \text{ m}^2/\text{s}$$

$$= 1.158 \times 10^{-6} \times 10^4$$

$$= 0.01158 \text{ stokes (Answer)}$$

5. (a) If a centrifugal pump does not deliver any water when started what may be the possible causes and how can they be remedied? 4

Causes	Cures
1. Lack of prime	Fill pump and suction pipe completely with liquid.
2. Loss of prime	Check for leaks in suction pipe joints and fittings; vent casing to remove accumulated air.
3. Suction lift too high	If no obstruction at inlet, check for pipe friction losses. However, static lift may be too great. Measure with mercury column or vacuum gauge while pump operates. If static lift is too high, liquid to be pumped must be raised or pump lowered.
4. Discharge system head too high	Check pipe friction losses. Larger discharge piping may correct condition. Check that valves are wide open.
5. Speed too low	Check whether motor is directly across-the-line and receiving full voltage. Alternatively, frequency may be too low; motor may have an open phase.
6. Wrong direction of rotation	Check motor rotation with directional arrow on pump casing. Wrong rotation will cause pump damage.
7. Impeller completely plugged	Dismantle pump or use piping hand hole to clean impeller.

(b) Compare impulse and reaction turbines. What is steam turbine staging?

Impulse Turbine	Reaction Turbine
1. Pressure drops takes place in nozzle only and pressure remains constant in moving blades. 2. Blade shape is profile type and its manufacturing cost is simple. 3. Blade passage is of constant cross-sectional area since there is no expansion. 4. Because of large pressure drop in nozzle ,the number of stage are less. 5. Because of large pressure drop, the blade speed and steam speed are larger. 6. Overall friction losses are more compared to leakage losses. 7. Occupies less space per unit power. 8. Suitable for small power.	1. Pressure drop takes place in both fixed blades and moving blades. Thus pressure values is different on the two sides of the moving blades. 2. Blade shape is aerofoil type and its manufacturing is difficult. 3. Blade passage is of variable cross-sectional area due to expansion. 4. Because of small pressure drop in each stage, the number of stage are larger for same pressure drop. 5. Because of small pressure drop, the blade speed and steam speed are small. 6. Leakage losses are more compared to friction loss. 7. Occupies more space per unit power. 8. Suitable for medium and large power.
Steam turbine staging: staging is basically stacking a group of turbines one after the other so that the steam gives up only part of its energy at each unit, or stage.	

(c) What is 'Cavitation' in hydraulic machines? How can cavitation in reaction turbines be avoided?

Cavitation in hydraulic machine: "Fundamentals of Mechanical Engineering Vol.1, chapter-3"

Reasons to avoid cavitation in reaction turbine: The cavitation in reaction turbines can be avoided to a great extent by using the following methods:

- (a) By installing the turbine below the tail race level.
- (b) By using stainless steel runner of the turbine.
- (c) By providing highly polished blades to the runner.
- (d) By running the turbine runner to the designed speed.

(d) A hydraulic turbine develops 10MW under a head of 25m at 135rpm. What is its specific speed and what type of turbine is it?

Solution: Given; $P=10\text{MW}=10000\text{kW}$; $H=25\text{m}$; $N=135\text{rpm}$; specific speed, $N_s=?$

We know;

$$N_s = \frac{N\sqrt{P}}{H^{5/4}}$$

$$N_s = \frac{135 \times \sqrt{10000}}{25^{5/4}}$$

$N_s = 241.495 \approx 242$ So it is francis turbine. (Answer)

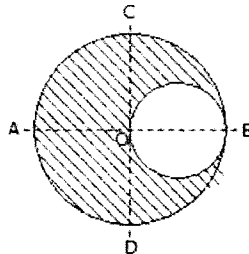
6. (a) Differentiate between (i) Statics and Dynamics (ii) Kinetics and Kinematics (iii) Beam and Column. 6

Statics	Dynamics
Statics is the branch of Engineering Mechanics which deals with the forces and their effect, while acting upon the bodies at rest.	Dynamics is the branch of Engineering Mechanics which deals with the forces and their effects, while acting upon the bodies in motion.
Kinetics	Kinematics
It is the branch of Dynamics, which deals with the bodies in motion due to the application of forces.	It is the branch of Dynamics, which deals with the bodies in motion without taking into account the forces which are responsible for the motion.
Beam	Column
Answer: see at “Fundamentals of Mechanical Engineering vol.1, Chapter-7”;	

- (b) Draw and label stress-strain diagram of Mild steel under tensile test. 6

Answer: see at “Fundamentals of Mechanical Engineering vol.1, Chapter-7”;

- (c) A cylinder hole of 50mm diameter is cut out from a circular disc of 100mm diameter as shown in figure. What is the center of gravity of the section? 8



Solution:

Given; $D = 100\text{mm} = 0.1\text{m}$, $d = 50\text{mm} = 0.05\text{m}$

This figure is symmetrical about x-axis, hence $\bar{y} = 0$

$$\text{Now } A_1 = \frac{\pi D^2}{4} = \frac{3.1416 \times 0.1^2}{4} = 0.007854\text{m}^2$$

$$A_2 = \frac{\pi d^2}{4} = \frac{3.1416 \times 0.05^2}{4} = 0.0019635\text{m}^2$$

$$A = A_1 - A_2 = 0.0058905$$

$$x_1 = 0.05\text{m and } x_2 = 0.1 - 0.025 = 0.075\text{m}$$

$$\bar{x} = \frac{A_1 x_1 - A_2 x_2}{A_1 - A_2} = \frac{(0.007854 \times 0.05) - (0.0019635 \times 0.075)}{(0.007854 - 0.0019635)} = 0.04167\text{m}$$

$$= 41.67\text{mm (Answer)}$$

7. (a) Define different types of beams with examples.

5

Answer: Following are the different types of beam:

1. Cantilever beam: A beam fixed at one end and free at other end is known as cantilever beam. Example- Cantilever bridge
2. Simply supported beam: a beam supported at its both ends known as simply supported beam. Example- bed of machine tools
3. Overhanging beam: A beam having its end portion extended beyond the support is known as overhanging beam. A beam may be overhanging on one side or both side. Example- A balcony which is being extended from a frame structure
4. Fixed beam: A beam, whose both ends are fixed is known as fixed beam. Example- Continuous beam: A beam supported on more than two supports is known as continuous beam. Example- Uniform girder bridge.

(b) What is meant by beam deflection? What are the possible methods of determining beam deflection?

Answer:

Beam deflection: Beam deflection means the state of deformation of a beam from its original shape under the work of a force or load or weight

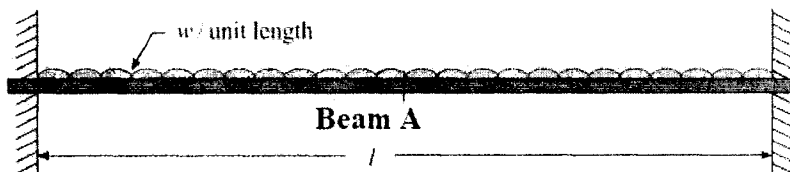
Following are the different possible methods of determining beam deflection-

1. Double integration method
2. Theorems of area moment method

Moment diagrams by part.

(c) Two fixed beams A and B are shown in figure. Calculate the ratio of maximum deflection of beam 'A' to maximum deflection of beam 'B'. Make necessary assumptions.

Answer:



We know that bending moment at any section X, at a distance x from A.

$$M_x = \mu_x - \mu'_x = \left(\frac{wl}{2} \cdot x - \frac{wx^2}{2}\right) - \frac{wl^2}{12}$$

$$\therefore EI \frac{d^2y}{dx^2} = \left(\frac{wl}{2} \cdot x - \frac{wx^2}{2}\right) - \frac{wl^2}{12} \dots \dots \dots (i)$$

Integrating the above equation,

$$EI \frac{dy}{dx} = \frac{wlx^2}{4} - \frac{wx^3}{6} - \frac{wl^2x}{12} + C_1$$

Where, C_1 is the first constant of integration. We know that when $x=0$, then $\frac{dy}{dx} = 0$.

Therefore, $C_1 = 0$.

$$\text{or, } EI \frac{dy}{dx} = \frac{wlx^2}{4} - \frac{wx^3}{6} - \frac{wl^2x}{12} \dots \dots \dots (ii)$$

Now integrating the equation (ii) once again,

$$EI.y = \frac{wlx^3}{12} - \frac{wx^4}{24} - \frac{wl^2x^2}{24} + C_2$$

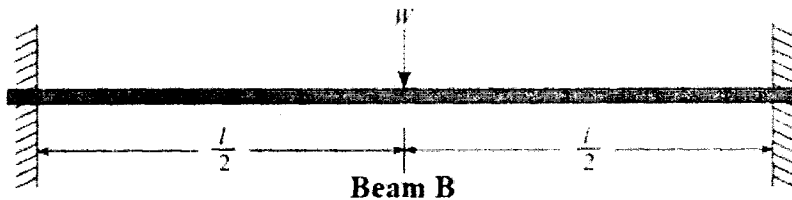
Where, C_2 is the second constant of integration. We know that when $x=0$, then $y = 0$. Therefore, $C_2 = 0$.

$$EI.y = \frac{wlx^3}{12} - \frac{wx^4}{24} - \frac{wl^2x^2}{24} \dots \dots \dots (iii)$$

We know that the maximum deflection occurs at the centre of the beam. Therefore substituting $x=l/2$ in the above equation,

$$EI.y_{ac} = \frac{wl}{12} \left(\frac{l}{2}\right)^3 - \frac{w}{24} \left(\frac{l}{2}\right)^4 - \frac{wl^2}{24} \left(\frac{l}{2}\right)^2 = -\frac{wl^4}{384} \quad [\because \text{Minus sign means that the deflection is downwards}]$$

$$\text{or, } y_{ac} = \frac{wl^4}{384EI}$$



From the geometry of the figure, we find that the points of contraflexure will be at a distance of $l/4$ from both the ends of the beam.

We know that bending moment at any section X, at a distance x from A,

$$M_x = \mu_x - \mu'_x$$

$$\Rightarrow EI \frac{d^2y}{dx^2} = \frac{Wx}{2} - \frac{Wl}{8} \dots \dots \dots (i)$$

Integrating the above equation,

$$EI \frac{dy}{dx} = \frac{Wx^2}{4} - \frac{Wlx}{8} + C_1$$

Where, C_1 is the first constant of integration. We know that when $x=0$, then $\frac{dy}{dx} = 0$.

Therefore, $C_1 = 0$.

$$\text{or, } EI \frac{dy}{dx} = \frac{Wx^2}{4} - \frac{Wlx}{8} \dots \dots \dots (ii)$$

This is the required equation for the slope of the beam at any section.

Now integrating the equation (ii) once again,

$$EI.y = \frac{Wx^3}{12} - \frac{Wlx^2}{16} + C_2$$

Where, C_2 is the second constant of integration. We know that when $x=0$, then $y = 0$.

Therefore, $C_2 = 0$.

$$\text{or, } EI.y = \frac{Wx^3}{12} - \frac{Wlx^2}{16} \dots \dots \dots (iii)$$

This is the required equation for the deflection of the beam at any section. We know that the maximum deflection occurs at the centre of the beam. Therefore substituting $x=l/2$ in the

above equation,

$$EI.y_{bc} = \frac{W}{12} \left(\frac{l}{2}\right)^3 - \frac{W}{16} \left(\frac{l}{2}\right)^2 = -\frac{Wl^3}{192}$$

or, $y_{bc} = -\frac{Wl^3}{192EI}$ [∵ Minus sign means that the deflection is downwards]

$$\therefore y_{bc} = \frac{Wl^3}{192EI}$$

The term EI is known as flexural rigidity.

We get, $y_{ac} = \frac{Wl^4}{384EI}$ and $y_{bc} = \frac{Wl^3}{192EI}$

$$\therefore \frac{y_{ac}}{y_{bc}} = \frac{l}{2} \text{ (Answer)}$$

Part II

Marks 20×5=100

8. (a) Mention some of the mechanical power transmission equipment with their relative advantages and disadvantages. 7

Answer: Belt technology: It is one of the most common devices. Belt drives are used to transmit motion from one shaft to another with the help of a thin inextensible band that runs over two pulleys. Advantages and disadvantages of belt technology is given below.

Advantages

1. Belt drives are cost-effective. New belt drive efficiency can be up to 95-98 percent
2. They are simple to use
3. Belt drives do not require parallel shaft
4. They have a low maintenance cost
5. They come with overload and jam protection
6. Different speeds can be obtained by means of step or tapered pulleys
7. When the distance between shafts is very large, belt drives are the most economical options
8. Damp out noise and vibration
9. Load fluctuations are shock-absorbed, increasing the machinery life
10. Clutch action can be activated by releasing belt tension

Disadvantages

1. Belt drives are not compact
2. Limited speed of around 35 meters per second
3. Compared to other mode power transmission, they have a short life service
4. Typically, its operating temperatures are restricted to -35 to 85°C
5. Angular velocity of belt drives isn't constant. This leads to stretching, slipping, and wearing of belt
6. It has limited power transmission of up to 370 kW, which increases the heat build-up
7. Belt drives usually inflict a heavy load on shafts and bearings
8. For wearing and stretching compensation, they additionally need an idler pulley or some adjustment of center distance
9. The velocity ratio varies because of belt slip

Chain Technology: chain drives come with an endless series of chain links with a net of toothed sprockets. Unlike belt drives, there is no slip in chain technology. However, they are mostly suited for small centre distances

Advantages

1. Positive drives with no slip or creep
2. Unlike belt drives, angular velocity remains constant in chain drives
3. High-velocity ratio of up to 8:1
4. It allows high speed ratio of 8 to 10 in one single step
5. Highly efficient, chain drives gives the advantage of more power compared to belts
6. It can be used for both small and large center distances
7. Chain drives have low maintenance cost
8. They give a high transmission efficiency of up to 98 percent
9. They can operate even in wet conditions
10. More compact and are easy to install compared to belt drive
11. Chain drives do not deteriorate due to sunlight, oil, grease, or age
12. Lower load on shaft than belt drives

Disadvantages

1. The initial cost of installation is higher than belt
2. The production cost is also relatively higher
3. Chain drives need regular lubrication
4. Driving and driven shafts must be perfectly aligned and parallel
5. They can have velocity fluctuations when unduly stretched
6. Not suitable for applications where it is necessary for the drive to slip
7. Chain drives are noisy and can also cause vibrations
8. They have lower load capacity and service life compared to gear drives

Gear Technology: In the world of mechanical power transmission, gear drives have a very special and prominent place. This is the most preferred technology when it is needed to transmit considerable power over a short distance with a constant velocity ratio. The mechanism of gear drives is quite simple – the teeth, which are cut on the blanks of the gear wheel, mesh with each other to transmit power.

Advantages

1. They are positive and non-slip drives
2. Large and constant velocity ratio of 60:1 can be obtained by using gear trains with minimum space
3. Gear drives are mechanically strong, allowing scopes for lifting higher loads
4. Longer service life compared to both belt and chain drives
5. They can transmit large power
6. Gear drives have high transmission efficiency
7. They can transmit motion over small centre distance of shafts
8. These drives are ideal for low, medium, high power transmission
9. Gears can transmit motion even between non-parallel intersecting shafts
10. These are the most compact compared to belt and chain drives

Disadvantages

1. Gear drives cannot be used for shafts with large center distances
2. They are not ideal for large velocities
3. These drives require regular lubrication and a more complicated process of applying it
4. Noise and vibrations are increased at a high speed
5. They are less economical compared to belt and chain drives
6. Using multiple gears increase the machine's overall weight
7. They have no flexibility
8. Not suitable for transmitting motion over a large distance

Some part of the machine can get permanently damaged because of the toothed wheel of gears. This is more common in case of excessive loading

(b) A fixed gear having 200teeth is in mesh with another gear having 50teeth. The two gears are connected by an arm. Calculate the number of turns made by the smaller gear for one revolution of the arm about the centre of the bigger gear.

Solution:

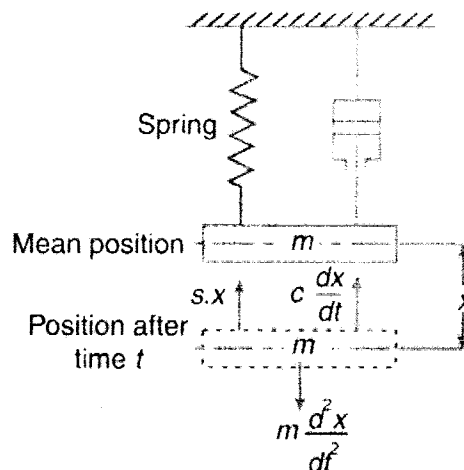
	Gear A	Arm	Gear B
Gear A fixed, arm rotates from +1 revolution	0	+1	$\frac{T_A}{T_B}$
	0	1	$\frac{T_A}{T_B}$
add 1 revolution		1	$1 + \frac{T_A}{T_B}$

Total revolution by gear B

$$= 1 + \frac{T_A}{T_B} = 1 + \frac{200}{50} = 1 + 4 = 5 \text{ (Answer)}$$

(c) Discuss the term under-damping, critical damping and over damping.

Answer:



Let, m = mass of suspended from the spring

s = stiffness of the spring

x = displacement of mass from the mean position at time t

δ = static deflection of the spring

c = damping coefficient

Damping force on the mass acting in opposite direction to the motion of mass

$$= c \times \frac{dx}{dt}$$

Accelerating force on the mass, acting along the motion of the mass

$$= m \times \frac{d^2x}{dt^2}$$

And spring force on the mass, acting in opposite direction of the mass

$$s \times x$$

Therefore the equation of motion becomes,

$$m \times \frac{d^2x}{dt^2} = -(c \times \frac{dx}{dt} + s \cdot x)$$

$$\text{or, } \frac{d^2x}{dt^2} + \frac{c}{m} \times \frac{dx}{dt} + \frac{s}{m} \times x = 0$$

This is the differential equation of second order. Assuming a solution of the form $x = e^{kt}$ where k is a constant to be determined, now the above equation reduces to

$$k^2 + \frac{c}{m} \times k + \frac{s}{m} = 0 \dots \dots \dots (1)$$

$$\text{and } k = -\frac{c}{2m} \pm \sqrt{\left(\frac{c}{2m}\right)^2 - \frac{s}{m}}$$

The two roots of the equation are

$$k_1 = -\frac{c}{2m} + \sqrt{\left(\frac{c}{2m}\right)^2 - \frac{s}{m}}$$

$$k_2 = -\frac{c}{2m} - \sqrt{\left(\frac{c}{2m}\right)^2 - \frac{s}{m}}$$

The most general solution of the differential equation (1) with its right hand side equal to zero has only complementary function it has given by

$$x = C_1 e^{tk_1} + C_2 e^{tk_2}$$

If $\left(\frac{c}{2m}\right)^2 > \frac{s}{m}$ then the roots k_1 and k_2 are real but negative. This is a case of overdamping.

If $\left(\frac{c}{2m}\right)^2 < \frac{s}{m}$ Then the radical becomes negative. This is a case of underdamping

If $\left(\frac{c}{2m}\right)^2 = \frac{s}{m}$ Then this is a case of critical damping.

9. (a) What are the effects of gyroscopic couple on an aeroplane and a naval ship? 4

Answer: See 38th BCS, part-II, 8.b.

(b) A vibrating system consists of a mass of 200Kg, a spring of stiffness 80N/mm 8

and a damper with a damping coefficient of 800N/m/s. Determine the frequency of vibration of the system.

Solution: Given: $m = 200 \text{ kg}$; $k = 80 \text{ N/mm} = 80 \times 10^3 \text{ N/m}$; $c = 800 \text{ N/m/s}$

We know the circular frequency of undamped vibrations,

$$\omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{80 \times 10^3}{200}} = 20 \text{ rad/s}$$

And circular frequency of damped vibrations,

$$\omega_d = \sqrt{1 - \xi^2} \omega_n$$

Where, $\xi = C/C_c$, and $C_c = 2m\sqrt{\frac{k}{m}} = 2\sqrt{km} = 2m\omega_n$

$$\omega_d = \sqrt{1 - \xi^2} \omega_n = 19.9 \text{ rad/s}$$

Frequency of vibration of the system,

$$f_d = \omega_d/2\pi = 19.9/2\pi = 3.17 \text{ Hz (Answer)}$$

(c) A shaft has two heavy rotors mounted on it. The transverse natural frequencies, considering each of the rotors separately, are 100Hz and 200Hz respectively. What is the lowest critical speed of the shaft?

Solution: Let f_n be the transverse natural frequency considering both rotors,

$$\therefore \frac{1}{f_n^2} = \frac{1}{f_1^2} + \frac{1}{f_2^2}$$

$$\Rightarrow \frac{1}{f_n^2} = \frac{1}{100^2} + \frac{1}{200^2}$$

$$f_n = 89.44 \text{ rps} = \text{critical speed} = \text{whirling speed}$$

$$= 89.44 \times 60 = 5367 \text{ rpm. (Answer)}$$

10. (a) Why is spark advance done in an SI engine? What are the effects of spark advance in an SI engine when it is done in, (i) over-advanced, (ii) normally advanced and (iii) retarded, fashion?

Answer: Spark Advance: Spark advance is a mechanism in which the spark is generated by the spark plug before the piston ends the compression stroke and reaches TDC. This is done to compensate with the chemical delay that takes place in a SI engine. The ignition timing needs to be increasingly advanced (relative to the TDC) as the engine speed increases, so that the air-fuel mixture has the correct amount of time to burn completely. As the engine speed increases, the time available to burn the mixture decreases while the burning itself proceeds at the same speed; this requires the burning to start earlier to complete in time. The correct timing advance for a given engine speed will allow for maximum cylinder pressure to be achieved at the correct crankshaft angular position.

Effects of spark advance: Timing advance is necessary because it takes time for the combustion of the air-fuel mixture to complete. Igniting the mixture before the piston ends its compression stroke would maximize the limit to which the mixture burns completely, and hence help to build up maximum pressure soon after the piston reaches the TDC. This would ensure maximum power output by maximizing the force with which the piston is pushed down, by maximizing the pressure as soon as the piston starts going down when the power

stroke is initiated. Ideally, the mixture should be completely burnt by 20° ATDC (after TDC).

Over advanced: If ignition timing is too far advanced, it will cause the fuel and air mixture to ignite too early in the combustion cycle. This can cause the amount of heat generated by the combustion process to increase and lead to overheating of the engine. If the timing is advanced too far, it will cause an Engine Knock.

Normally advanced: Normally ignition starts 20 to 30 degree before the TDC. It ensures enough time for the air fuel mixture to burn properly.

Retarded ignition timing: Retarded timing can be defined as changing the timing so that fuel ignition happens later than the manufacturer's specified time. For example, if the timing specified by the manufacturer was set at 12 degrees before TDC initially and adjusted to 11 degrees before TDC, it would be referred to as retarded. If the ignition is too retarded relative to the piston position, the maximum cylinder pressure will occur after the piston has already travelled too far down the cylinder. This would result in lost power accompanied by high emissions and unburnt fuel.

(b) What are the major sources of renewable energy? Discuss their status in Bangladesh.

Answer: See 34th BCS second paper, 5.a

(c) What are the effects of the variable load on the power plant design application? 5

Answer: The variable load problem affects power plant design and operation and the cost of generation. To supply variable load a careful study of load duration curve is needed. This will help to decide the capacity of base load plant and peak load plant. The base load plant should be run at high load factor. The peak load plant should be of as small capacity as possible to reduce cost per kilowatt hour (kWh). Economical load sharing between base load plant and peak load plant is desirable. Steam power plants and nuclear power are preferred as base load plants whereas diesel power plant and hydro power plant can be used as peak load plant. Hydro power plant with larger water storage can also be used as base load plant. If the whole of load is to be supplied by the same power plant then the prime movers and generators should act fairly quickly and take up or shed load without variation of the voltage or frequency of the system. An important requirement is therefore the control of supply of fuel to the prime mover by the action of governor. The equipment to be used for variable load conditions should be so designed that it operates at lower loads with nearly same efficiency as at full load. The size of the generators should be so chosen as to suit and fit into the portions of the predicted load curve. If the load conditions differ too much from the ideal the cost of energy increases.

11. (a) Compare forced convection with free convection using suitable examples. 5

Why is natural convection so important despite having low rate of heat transfer?

Solution: In forced convection the fluid is forced to move by external means such as a fan, pump, or the wind. The fluid motion in natural convection is due to buoyancy effects only.

Example of natural convection : The formation of land and sea breeze is one of the classic examples of convection. The Sun heats up both land and sea surface during the day. But since the land has less heat-absorbing capacity than the sea, its surface temperature increases, heating up the air around it. The warm (less dense) air begins to rise, and low pressure is

created.

At the same time, a high-pressure area develops (with cold, dense air) over the top of the sea. Due to the difference in pressure, air flows from the sea to the land, and the cold air that comes along is called a sea breeze.

The process gets reversed during the night. The land cools down quicker than the sea, decreasing the air temperature around it and creating a high-pressure situation. Now the cold air flows from the land to the sea, and this is what we call the land breeze.

In both cases, the heat transfers through air molecules.

Example of forced convection: Everyday examples of forced convection can be seen with air conditioning, central heating, cooling hot food with fan, a car radiator using fluid, or a convection oven.

Importance of natural convection: The temperature of the air adjacent to the hot object is higher, thus its density is lower. As a result, the heated air rises. This movement is called the natural convection current. The heat transfer that is enhanced as a result of this natural convection current is called natural convection heat transfer. In general, a free convection heat transfer is usually much smaller than a forced convection heat transfer. It is therefore important only when no external flow exists.

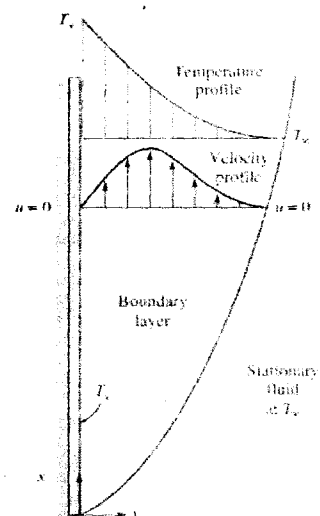
(b) Draw and explain the free convection boundary layer over a heated vertical plate.

Answer:

Answer: The thickness of the boundary layer increases in the flow direction. Fluid velocity is zero at the outer edge of the velocity boundary layer and at the surface of the plate.

At the surface, the fluid temperature is equal to the plate temperature. In the case of cold surfaces, the shape of the velocity and temperature profiles remains the same but their direction is reversed.

In the figure, a typical velocity and temperature profiles for natural convection over a hot vertical plate at temperature T_s inserted in a fluid at temperature T_∞ .



(c) Define human comfort. List the major equipment used in a central air- conditioning system.

Answer: Human thermal comfort is defined as a condition of mind, which expresses satisfaction with the surrounding environment. High temperatures and humidity provide discomfort sensations and sometimes heat stress (i.e., reducing the body's ability to cool itself).

In a central hydronic air conditioning system, air is cooled or heated by coils filled with chilled or hot water distributed from a central cooling or heating plant. It is mostly applied to large-area buildings with many zones of conditioned space or to separate buildings. A central air conditioning system consists of an air system, a water system, a central heating/cooling plant, and a control system.

Air System: An air system is sometimes called the air-handling system. The function of an air system is to condition, to transport, to distribute the conditioned, recirculating, outdoor, and exhaust air, and to control the indoor environment according to requirements.

The major components of an air system are the air-handling units, supply/return ductwork, fan-powered boxes, space diffusion devices, and exhaust systems.

Water System: The water system includes chilled and hot water systems, chilled and hot water pumps, condenser water system, and condenser water pumps. The purpose of the water system is to transport chilled water and hot water from the central plant to the air-handling units, fan-coil units, and fanpowered boxes and to transport the condenser water from the cooling tower, well water, or other sources to the condenser inside the central plant.

Central Plant: The refrigeration system in a central plant is usually in the form of a chiller package. Chiller packages cool the chilled water and act as a cold source in the central hydronic system. The boiler plant, consisting of boilers and accessories, is the heat source of the heating system. Either hot water is heated or steam is generated in the boilers.

Control System : Modern air conditioning control systems for the air and water systems and for the central plant consist of electronic sensors, microprocessor-operated and -controlled modules that can analyze and perform calculations from both digital and analog input signals, i.e., in the form of a continuous variable. Control systems using digital signals compatible with the microprocessor are called direct digital control (DDC) systems. Outputs from the control modules often actuate dampers, valves, and relays by means of pneumatic actuators in large buildings and by means of electric actuators for small projects.

(d) Mention different sources of heat to be considered for the calculation of cooling load for any building for summer air conditioning.

Solutions: Different sources of heat are to be considered for the calculation of cooling load for any building for summer air conditioning.

1. Heat leakage through the fabric by conduction from warmer surroundings.
2. Heat gain by radiation through transparent surfaces – usually solar but occasionally by other means (radiant heat from a process, such as furnaces).
3. Heat gain by forced or natural convection – air infiltration and fresh air supply – sensible and latent heat.
4. Internal heat sources – lights, people, machines, etc. – sensible and latent heat.

12. (a) What is work sampling? What measures can be taken to ensure representative work sample in work sampling?

Answer: Work sampling is the statistical technique used for determining the proportion of time spent by workers in various defined categories of activity (e.g. setting up a machine, assembling two parts, idle etc.). It is as important as all other statistical techniques because it permits quick analysis, recognition, and enhancement of job responsibilities, tasks, performance competencies, and organizational work flows. Other names used for it are

'activity sampling', 'occurrence sampling', and 'ratio delay study'.

In a work sampling study, a large number of observations are made of the workers over an extended period of time. For statistical accuracy, the observations must be taken at random times during the period of study, and the period must be representative of the types of activities performed by the subjects.

One important usage of the work sampling technique is the determination of the standard time for a manual manufacturing task. Similar techniques for calculating the standard time are time study, standard data, and predetermined motion time systems.

Measures to ensure representative sampling:

Researchers use two methods to build representative samples – Probability sampling and non-probability sampling.

1. Probability sampling: Probability sampling is a technique in which a researcher chooses a sample from a larger population using a method based on the probability theory. For a participant to be considered a probability sample, he/she must be selected using a random selection.

If we will use probability sampling to obtain a representative sample, then simple random sampling is the best choice. The sample choice is made at random, which guarantees that each member of the population will have the same probability of selection and inclusion in the sample group.

2. Non-probability sampling: Non-probability sampling is a sampling technique in which the researcher selects samples based on the researcher's subjective judgment rather than random selection. In non-probability sampling, not all population members have a chance of participating in the study, unlike probability sampling, where each member of the population has a known chance of being selected.

Knowing the selected sample's demographic characteristics will undoubtedly help limit the profile of the desired sample and define the variables that interest us, such as gender, age, place of residence, etc. By knowing these criteria, before obtaining the information, we can have the control to create a representative sample that is efficient. We must avoid having a sample that does not reflect the target population. The idea is to have the most accurate data possible for our project's success.

(b) What is a control chart? How is the lack of control indicated on a control chart? 7

Answer: The control chart is a graph used to study how a process changes over time. Data are plotted in time order. A control chart always has a central line for the average, an upper line for the upper control limit, and a lower line for the lower control limit. These lines are determined from historical data. By comparing current data to these lines, you can draw conclusions about whether the process variation is consistent (in control) or is unpredictable (out of control, affected by special causes of variation).

Control charts can indicate problems with the process when assignable causes exist in the system. The process with assignable causes is said "out-of-control". In this case, some data points for the control charts will be out of the control limits. In other words, if any measurement or test data is outside the control limits, we will know that something wrong exists in the process. Definitely, it is the time to take corrective actions.

(c) For a small-scale industry, the fixed cost per month is Taka 7000, the variable cost per 6

product is Taka 25 and selling price is Taka 35 per product. What is the break-even production volume per month?

Solution:

$$\begin{aligned}\text{Break even volume, } Q &= \frac{F}{P - V} \\ &= \frac{7000}{35 - 25} \\ &= 700\end{aligned}$$

Here,

F = Fixed Cost

P = Sales price per unit

V = Variable cost per unit

13. (a) What is continuous casting and what advantages does it offer?

4

Continuous casting: Continuous casting allows metals and alloys to be stretched, shaped and solidified without the need for an interruption, reducing waste while improving yield, cost efficiency, and quality.

Advantages

1. The process is cheaper
2. Casting surfaces is better
3. Grain size and structure of the casting can be easily controlled
4. High production rate
5. Process is automatic
6. Product has good consistent soundness

Mechanical properties are high and reproducible

(b) How do brazing and braze welding differ and how are they alike? How do they differ from welding and soldering?

4

Answer: Difference between brazing and braze welding is given below:

Brazing	Braze Welding
In brazing the filler metal is drawn into a tight-fitting joint by capillary attraction	In braze welding the filler metal is deposited in the joint by other than capillary attraction
Brazing is with filler material, the base material is not liquified	Braze welding is between both; often is it understood to melt just one joining partner and braze it to an other one with or without filler material

Similarities: Similar to welding, brazing creates a mechanical connection between to metal parts. Filler metal has melting point above 450°C.

Difference between welding and soldering is given below:

Welding	Soldering
Base metal fused	Base metal doesn't fuse
High temperature, high power	Low temperature, low power
High distortion	No distortion
High stresses in joint	Low stresses in joint
Microstructure of base metal changes	No chages in microstructure of base metal
Dissimilar metals difficult to joint	Dissimilar metal easy to joint

High strength of joint	Low strength of joint
Thin sheet difficult to weld	Thin sheet can be joined easily

(c) What are thermometry and pyrometry? Enlist some instruments of high temperature measurement and control. 6

Answer: Thermometry: The branch of heat relating to the measurement of temperature of a body is called thermometry.

Pyrometry: Pyrometry is the process of measuring the temperature of an object by gauging its infrared radiation and is usually assumed to refer to operations under high-temperature conditions. An instrument called a pyrometer, which is a type of thermometer, is used for this process. A pyrometer in which high temperatures are judged by comparing the colour of a hot object with a reference colour scale.

Some instruments of high temperature measurement and control is enlisted below

1. Pyrometer
2. Thermocouples.
3. Thermistors.
4. Resistance temperature detector (RTD)
5. Infrared thermometer
6. Langmuir probes (for electron temperature of a plasma)

(d) What is an LVDT? How can this be used to measure the displacement of an object? 6

Answer: An LVDT (linear variable differential transformer) is an electromechanical sensor used to convert mechanical motion or vibrations, specifically rectilinear motion, into a variable electrical current, voltage or electric signals, and the reverse. Actuating mechanisms used primarily for automatic control systems or as mechanical motion sensors in measurement technologies.

Way of measuring displacement of an object:

An LVDT measures displacement by associating a specific signal value for any given position of the core. This association of a signal value to a position occurs through electromagnetic coupling of an AC excitation signal on the primary winding to the core and back to the secondary windings. The position of the core determines how tightly the signal of the primary coil is coupled to each of the secondary coils. The two secondary coils are series-opposed, which means wound in series but in opposite directions. This results in the two signals on each secondary being 180 deg out of phase. Therefore phase of the output signal determines direction and its amplitude, distance

14. (a) State and explain the steps that should be taken in setting up an organization. 6

Answer: Steps for setting up an organization are:

1. **Clearly defined objectives:** The first step in developing an organizational structure is to lay down its objectives in very clear terms. This will help in determining the type and basic characteristics of the organization; organization activities are detailed in terms of objectives to be achieved.
2. **Determining activities:** In order to achieve the objectives of the enterprise, certain activities are necessary. The activities will depend upon the nature and size of the enterprise. Each major activities is divided into smaller parts.

3. **Assigning duties:** The individual groups of activities are then allotted to different individuals according to their ability and aptitude. The responsibility of every individual should be defined clearly to avoid duplication and overlapping of effort. Each person is given a specific job suited to him and he is made responsible for its execution. Right man is put on the right job.
4. **Delegating authority:** Every individual is given the authority necessary to perform the assigned activity effectively. By authority we mean power to take decisions, issue instructions, guiding the subordinates, supervise and control them. Authority delegated to a person should commensurate with his responsibility. An individual cannot perform his job without the necessary authority or power. Authority flows from top to bottom and responsibility from bottom to top.
5. **Co-ordinating activities:** The activities and efforts of different individuals are then synchronized. Such co-ordination is necessary to ensure effective performance of specialized functions. Inter-relationship between different jobs and individuals are clearly defined so that everybody knows from whom he has to take orders and to whom he is answerable.
6. **Providing physical facilities and right environment:** The success of an organization depends upon the provision of proper physical facilities and right environment. Whereas it is important to have right persons on right jobs, it is equally important to have right working environment. This is necessary for the smooth running and the prosperity of the enterprise.
7. **Establishment of structural relationship for overall control:** It is very essential to establish well defined clear-cut structural relationships among individuals and groups. This will ensure overall control over the working of all departments and their coordinated direction towards the achievement of pre-determined goals of business.

(b) What is meant by management? How does it differ from administration? 5

Answer: Management: Management is a process of planning, decision making, organizing, leading, motivation and controlling the human resources, financial, physical, and information resources of an organization to reach its goals efficiently and effectively.

Management differ from administration:

- Management consists of actions and plans whereby administration entails setting objectives and policies.
- Management aims at managing not only people but also their work. Whereas Administration focuses on how best the resources of an organization can be utilized.
- Administration typically has a role in all management decisions, whereas not all administrative decisions require the input of management.
- Administration is focused on setting and creating policies and procedures. Management however is more likely to deal with the broader functions of an organization and how tasks are executed.
- Administrative functions typically are more defined, whereas how managers act

and operate in an organization can differ person to person.

- The management style of an organization can also change with the removal or installation of a new Manager/Leader. Administrative policies or procedures however are slower to change and may remain in place for many generations of management.
- The administrative functions of a business can often be guided or influenced by legislation or law. Whereas how a manager chooses to guide or lead their team is often a function of their experience and the company culture.

These are some of the core differences between management and administration.

(c) What should determine the span of control in organizational design? 5

Answer: The span of control determines the level of interactions and responsibilities associated with employees and managers. The process is used to determine the management style and it also defines roles within the organization. The importance of span of control and its concepts are relative to productivity in the workplace by determining the number of employees that fall under each individual manager.

(d) Name the basic sub-functions of personnel management and discuss them. 5

Answer: Sub-functions of personnel management are:

1. **Organizational planning and development:** Planning is essentially concerned with the distribution or allocation of various jobs to be performed into manageable and effective or efficient well-integrated departments, units or divisions or positions, exercising effective supervision and control.
2. **Employment:** This includes man power planning, recruitment, selection, placement, induction etc. Man power planning is the process of analysing the existing and potential future vacancies in various departments. Recruitment is the process of attracting or acquiring qualified and competent personnel for various jobs and study of the labour market, identifying existing sources and developing new sources of man power supply.
3. **Training and development personnel:** This includes the building and implementation of various training and development programmes for employees at all levels in the organization, with a view to increase their skill and efficiency necessary for effective contribution towards the accomplishment of organizational objectives.
4. **Wage and salary administration:** This includes job evaluation, development of a suitable wage structure, development of incentive plans, motivational techniques, development of an effective communications system and preparation, implementation and evaluation of merit rating plans.
5. **Employee benefits and services:** This includes formulation, implementation and evaluation of various welfare activities, group insurance plans, provision of pensions, gratuity and other such payments, fringe benefits, ensuring fulfilment of social security and welfare provisions as provided through legislation and provisions regarding health and safety and employee counselling with a view to solving personnel problems of employees.
6. **Labour Relations:** This includes collective bargaining, negotiating and administering

agreements or contracts, grievance handling, maintenance of discipline, joint consultations and development of healthy and peaceful union management relations.

7. Personnel research and audit: This involves continuing studies on various aspects of personnel relations and personnel procedures and practices with a view to bring about necessary improvements in personnel management. Audit is necessary for ensuring the effectiveness of personnel policies and practices

Based on BCS questions solution and other job exam questions solution we can make a list of books for taking job preparation effectively:

Name of the books	Name of the writers
Thermodynamics	
Thermodynamics: An Engineering Approach	Michael A. Boles and Yunus A Çengel
A text book of thermal engineering	R.S. Khurmi & J.K. Gupta
The Principles of Thermodynamics	N.D Hari Dass
Engineering Thermodynamics	G.F.C. Rogers & Y.R. Mayhew
A Textbook of Engineering Thermodynamics	R.K. Rajput
Engineering Thermodynamics	P K Nag
Heat Engineering	V.P. Vasandani & D.S. Kumar
IC Engine	
Internal Combustion Engine Fundamentals	Jhon B. Heywood
Internal Combustion Engines	Obert Edward Frederic
Internal Combustion Engine	M.L. Mathur & R.P. Sharma
IC Engines and Compressors	R.K. Singal
IC Engines	V Ganesan
Fluid Mechanics	
Fluid mechanics through worked out problems (Volume-1&2)	Quamrul Islam , Md Mondal , Amalesh Chandra.
Fluid Mechanics	Yunus Cengel
Hydraulic Machines	R.K. Rajput
Fluid Machines & Hydraulic Machines	Dr. R.K. Bansal
Fluid Mechanics	Frank M White
A text of Hydraulic Fluid Mechanics & Machines	R.S. Khurmi
Fluid Mechanics	Victor L. Streeter
Hydraulics Fluid Mechanics	Modi-Seth
Heat Transfer	
Heat Transfer	J.P. Holman & Souvik Bhattacharyya
Heat Transfer	Yunus A.Cengel
Heat & mass Transfer	R.K. Rajput

Power Plant Engineering

Principles of Power System

V.K Mehtha & Rohit Mehtha

Power Plant Engineering

G.R. Nagpal

Power Plant Engineering

P.K.Nag

Refrigeration & Air Conditioning

A text book of Refrigeration & Air Conditioning

R.S. Khurmi & J.K. Gupta

Refrigeration & Air Conditioning

Wilbert F.Stoecker & Jerold W.Jones

Refrigeration and Air Conditioning

C.P. Arora

Refrigeration and Air Conditioning

P.L. Ballaney

Strength of Materials

Strength of Materials

Andrew pytel & Ferdinand L. Singer

A Textbook of Strength of Materials

R. K. Bansal

Theory of Machines

Theory of Machines

R.S. Khurmi & J.K. Gupta

Theory of Machines

Joseph E. Shigley

Engineering Mechanics

Vector Mechanics For Engineers (Statics)

Ferdinand P. Beer & E. Russell Jhonston

Vector Mechanics For Engineers (Dynamics)

Ferdinand P. Beer & E. Russell Jhonston

Engineering Mechanics: Statics & Dynamic

Russell C. Hibbeler

Machine Tool/ Manufacturing Technology

Manufacturing Processes & Materials

Doyle, George F. Schrader

Manufacturing Processes

U.K. Singh & Manish Dwivedi

Manufacturing Technology foundry, forming and welding

P. N. Rao

Automobile Engineering

Automotive Mechanics

William H. Crouse & Donald L Anglin

Engineering Drawing

Mechanical engineering drawing

Mandal , Amalesh Chandra; Quamrul Islam

Production & Operations Management

Production and Operations Management

Raymond R Mayer

Industrial Engineering and Management

O.P. Khanna

Industrial Engineering And Management

Pravin Kumar

Operations Management

William.J.Stevenson

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If you have any query or suggestion about this book, please feel free to contact him.

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